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Eleven Layer Hemispheric Model Five-day Forecasts from Data Supplied by NCAR

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Introduction

This note describes the results of six five-day forecasts from data supplied by the United States National Center for Atmospheric Research (NCAR), using the Met O 20 eleven level model (for description see Saker 1975). The times and dates of the initial fields were chosen to allow comparisons with the experiments of several other numerical modellers (for example, Druyen and Somerville)

The six initial fields are for

12 December 1972 at 12Z

20 December 1972 at 00Z

22 December 1972 at 00Z

11 January 1973 at 00Z

12 January 1973 at 12Z

14 January 1973 at 00Z

Assessments of the forecasts were done in two ways:

(a) Synoptic verification - subjective assessment of the 500 mb and PMSL charts at 24 hour intervals throughout the period of each forecast;

(b) Statistical verification - root-mean-square (rms) forecast errors, compared with persistence, for the 500 mb and 1000 mb levels. Persistence is defined as the initial values remaining unchanged throughout the period of the forecast.

The Data

The data used were the NCAR model intercomparison series for 12-31 December 1972 and 11-22 January 1973 at 12 hour intervals, containing NMC analysed geopotential for 1000, 700, 500, 300, 200 and 100 mb, and NCAR u and v wind components which had been linearly interpolated from the original pressure levels to 3 km increments of geometric height from 1.5 km to 16.5 km. The grid used has a 2.5° latitude separation (0° - 87.5°N) and 2.5° longitude separation covering the whole northern hemisphere.

Interpolation of Data

The Met O 20 eleven level model requires data with a 2° latitude separation (1° - 89° north) which is about 220 km, with a variable number of points on each line of latitude to give a similar resolution at all latitudes (ie a Kurihara grid). It also requires the data to be in sigma coordinate form instead of at fixed pressure

levels, with temperature and water content at each level, and a surface pressure, in place of the geopotential heights available from NCAR.

First, each whole NCAR hemispheric data set was linearly interpolated from its original grid on to the eleven level model grid. Next, mean temperatures were calculated from the heights available using the hydrostatic equation, and were assumed to apply to the mid-points of the layers, ie at 850, 600, 400, 250 and 150 mb. A value for a 1000 mb temperature was extrapolated from 850 mb using a 6.5°C/km lapse rate. Using the normal Met O 20 topography, values for 1000 mb height, the surface pressure and surface temperature were deduced, and thence the values of temperature at each sigma level.

In the absence of any humidity data, relative humidity was assumed to be 70% throughout for calculation of water content. The wind components supplied by NCAR were interpolated linearly to the sigma levels where possible. For winds near the surface it was necessary to assume the neutral boundary layer logarithmic wind profile below the lowest available level.

For simplicity when running the statistical verification package of computer programmes, all the NCAR data were transformed into two continuous sequences of data on magnetic tape, in the same format as would be produced by an eleven level model forecast when dumping data to tape. Thus any initial data field could be selected easily for input to the model, and the normal set of chart plotting programmes could be used on either initial data or forecast dumps.

Synoptic Assessments

Assessment of any forecast is very much an individual matter, so we have stated the scheme adopted for each case. The most significant features are mentioned, together with developments in the Atlantic and Europe. Some of the forecasts cover periods which overlap; in these cases, significant troughs and low pressure centres have been identified as T1, T2, or L1, L2 etc, to make it easier to follow the same feature in different forecasts.

(1) Data time 12Z 12/12/72

At the beginning of the period a weak 500 mb ridge over Eastern Europe is relaxing as it moves east and a southwesterly jet extends across UK to the next major

500 mb trough at 40° to 50° west. This trough swings eastward during day 1 and day 2, phases in with an old trough at 20° west and slows down as its amplitude is increased. Ahead of the Atlantic trough a 500 mb ridge is developing over the North Sea. Between day 1 and day 2 a deepening surface low moves out from Nova Scotia, merges with the old Atlantic surface low, and the Atlantic trough and Scandinvian ridge are both retrogressed between day 3 and day 4. Further amplification of the 500 mb trough and ridge on day 5 renders the wave pattern across UK stationary with a southerly jet lying west of Ireland. A new deepening depression moves into the Atlantic from Nova Scotia between day 4 and day 5.

Assessment scheme:

(i) Amplification of the Atlantic trough and Scandinavian ridge, their retrogression and degeneration to a stationary pattern.

(ii) Development of a large amplitude upper flow over the Pacific.

Performance. The movement of the first low out from Nova Scotia was a little slow (less than a day), and although retrogression and amplification of the upper pattern was a little weak, these were still very well done, Indication of the second low out of Nova Scotia was about a day late.

The increase of amplitude of the upper flow over the Pacific between days 1 and 3 was well forecast.

(2) Data time 00Z 20/12/72

On day 0 there is a large amplitude 500 mb trough from Central Russia to the eastern Mediterranean with an equally large amplitude ridge to the west of it stretching from Scandinavia to Iberia. The next 500 mb trough (T1) is over the central Atlantic. The European trough-ridge system is slow-moving but nevertheless mobile. The Atlantic trough T1 is more mobile still, crosses UK on day 4 when it is relaxing, and the associated deep surface low (L1) northwest of Scotland on day 2 is transferred northeast leaving a residual low over the Norwegian Sea on day 4.

Over Central USA there is the weak 500 mb trough (T2) on day 0. By day 2 a cut-off circulation forms in the southern part of T2 after it has sharpened considerably between day 0 and day 1. The southern part (T2B) is held back, whilst from day 3 onwards the northern part (T2A) breaks away, deepens and moves rapidly into the Central Atlantic, creating a deep surface low (L2) there and giving strong southerlies over UK on day 5.

A strong zonal flow across the Pacific is maintained throughout most of the period.

Assessment scheme:

(i) Does the trough T1 cross UK on day 4 when it is relaxing?

(ii) Is the development of T2 and L2 well forecast?

(iii) Maintenance of strong zonal flow across the Pacific.

Performance

(i) T1 is over UK on day 4 and has relaxed.

(ii) The development of T2 is indicated but far too weakly, so there is no deep surface low to the west of UK on day 4 and day 5.

(iii) The main features over the Pacific are well forecast.

It is, therefore, a poor forecast after day 3 due to lack of development of T2, but a good forecast over the Pacific.

(3) Data time 00Z 22.12.72

On day 0 there is a weak 500 mb ridge over Russia and central Europe and a fast-moving 500 mb trough (T1) over the central Atlantic. T1 crosses UK on day 2 when it is relaxing and the associated surface low (L1) north of Scotland fills.

On day 0 a cut-off circulation has formed in the base of a 500 mb trough (T2) over central USA and the next 500 mb trough (T3) is a weak feature off the west coast of USA. By day 1 the upper part of T2 (T2A) has broken away and it moves very rapidly east to become well developed by day 2 over the central Atlantic with a deep surface low (L2) forming beneath it. This low persists west of UK, producing strong surface southerlies over UK. Developing T2A throws warm air northwards ahead of it and a strong 500 mb ridge develops over Scandinavia. The pattern across Europe and the eastern Atlantic is now slow moving.

The trough T3 is retrogressed on day 1 but thereafter moves steadily across USA to reach 80° west by day 5.

Assessment scheme:

(i) The development of T2A and L2.

(ii) The progress of T3.

Performance

(i) T2 is badly underdeveloped with the result that the surface pressure west of UK on day 3 is about 40 mb too high.

(ii) T3 is followed quite well at first but is about 20^{o} of longitude slow by day 5.

This is a bad forecast since T2 is not sufficiently developed by day 2.

(4) Data time 00Z 11.1.73

On day 0 a surface low (L1) over European Russia lies on the eastern flank of a 500 mb blocking ridge whose axis and central circulation are over the North sea. West of the block a 500 mb trough (T1) extends southeastwards into Biscay from L2 which is southwest of Greenland. Consequently there is a strong cyclonic southerly over western UK and a weak anticyclonic southerly over Eastern UK. Another 500 mb trough (T2) associated with L2 is moving eastwards across the Atlantic, and a further trough (T3) lies over central USA.

Between day 0 and day 3 the Biscay trough (T1) relaxes but the Atlantic trough (T2) moves in to phase-in with its remains and create a new sharp trough over Biscay. The result is that the gradient on the western side of the block is tightened and the strong southerlies are extended eastward across the North Sea with the block axis hardly moving. A new low (L3) forms on day 1 as a southeastward extension of L2, ahead of the upper part of T2, and this low L3 remains as a deep feature southwest of Iceland with a southeastward extension of it swinging north. On day 2 there is a weak low (L4) east of Florida which moves eastward and deepens, becoming a major feature WNW of Spain by day 5. The Russian low (L1) moves Southeast towards the Caspian Sea and fills (day 0 to day 3).

On day 0 there is a 500 mb ridge over the Rockies with a low (L5) off the west coast of Canada. Low pressure extends from L5 to Japan, east of which another low (L6) is developing. Between day 0 and day 3, L5 moves northwards up the western flank of the 500 mb ridge and the ridge is severely weakened. Between day 3 and day 5 L6 fills as a new centre forms to the east. This new centre moves towards the Canadian coast and there is troughing towards the Great Lakes.

Assessment scheme:

(i) Treatment of Russian low (L1) from day 0 to day 3.

(ii) Creation of Atlantic low (L3) and its subsequent development.

(iii) Maintenance of European blocking ridge and the eastward transfer of surface southerlies to the west of it.

(iv) Treatment of Florida low (L4) day 2 to day 5.

(v) Transfer of new centre from L6 to Canadian coast (day 3 to day 5),

Performance

(i) The tracking and filling of L1 is well forecast.

(ii) L3 is created but it is too shallow by 16 mb and too far south by day 3.

(iii) The European blocking ridge is maintained and surface southerlies are transferred across the North Sea.

(iv) L4 is not developed as a centre although there is some insignificant troughing eastwards.

(v) The eastwards transfer of a centre from L6 is indicated.

With the exception of (iv) the model produced a fairly good forecast.

(5) Data time 12Z 12.1.73

On day 0 a low (L1) near the Black Sea lies on the eastern flank of a 500 mb blocking ridge whose axis lies across Spain, Germany and Scandinavia. West of the block, a deep 500 mb trough (T2) extends southeastwards into the Atlantic from a low (L3) near Cape Farewell. Consequently there is a southerly flow over UK, which is strong in the west. Another 500 mb trough (T3) associated with L3 lies along the US eastern seaboard and is moving into the Atlantic.

During day 0 to day 3 trough T2 moves into Biscay where it stops and is reinforced by the southeastward extension of T3. The result is that the gradient on the western side of the European block is tightened and the strong surface southerlies are extended across the North Sea without the axis of the block moving appreciably. Atlantic L3 is deepened as the northern part of T3 moves into it and L3 remains as a deep feature southwest of Iceland. On day 1 there is a weak low (L4) east of Florida and this moves east and deepens becoming a major feature off northwest Spain by day 4. By day 5 it has moved into Biscay and filled.

On day 0 there is a weak 500 mb ridge over the Rockies with a surface low (L5) off the west coast of Canada which remains stationary and fills between day 0 and day 2. Another low (L6) west of Japan moves slowly east and deepens (day 0 to day 2) but from day 3 onwards it fills as the main centre is transferred eastwards towards the west coast of Canada where it stops with troughing occurring towards the Great Lakes.

Assessment scheme:

(i) Development of Atlantic low L3 from day 1 to day 2, the maintenance of the European blocking ridge and the eastward extension of strong surface southerlies from day 1 to day 3.

(ii) Development and movement of L4 from day 1 onwards.

(iii) Transfer of new centre from L6 to Canadian coast from day 3 onwards.

Performance

(i) The position and intensity of L3 is well forecast although a little too far south, the European ridge is maintained and the strong surface southerlies are extended eastwards.

(ii) The movement of L4 is weakly indicated by troughing eastward but a proper centre is never developed.

(iii) An indication of the eastward transfer of a centre from L6 is given although the result does not look much like a synoptic chart.

The main defect of the forecast is that L4 is not developed properly. Otherwise the forecast is fairly good.

(6) Data time 00Z 14.1.73

On day 0 there is a 500 mb blocking ridge over Scandinavia, central Europe and the western Mediterranean. West of this block a quasi-stationary 500 mb trough (T2) extends southeastwards towards Spain from a deep low (L3) near Cape Farewell. Another 500 mb trough (T3) associated with L3 is progressing across the Atlantic and there is another trough (T4) lying over the east coast of USA.

The blocking ridge is maintained throughout the period. Between day 0 and day 1 the trough T3 phases-in with T2 over Biscay to form a strong trough T3*. This trough now splits, the lower part moving slowly into the Mediterranean and the upper part swinging northeastwards across UK. A minor trough from central USA runs into T4 on day 1 and retrogresses it, and a surface low (L4) forms under the forward flank of T4. L4 moves rapidly across the Atlantic to become a major feature west of Spain by day 2. Thereafter it fills (very rapidly day 3 to day 4) and slips into the Central Mediterranean weakening the base of the European 500 mb blocking ridge as it goes. The result is a breakdown of upper southerlies over UK.

On day 0 a trough-pair spans the Pacific. The first lies off the west coast of USA/Canada with a weak surface low (L5) beneath. The second lies over the northwest Pacific and has a deeper surface low (L6) associated with it. Between the two troughs there is a weak 500 mb ridge.

Between day 1 and day 2 the main Pacific surface centre is transferred eastward to become a deepening low (L7) off the east coast of Canada/USA. Meanwhile L6 fills and in the 500 mb ridge a circulation develops at about 60° north. Between day 3 and day 4 a new low (L8) south of L6 deepens rapidly and moves northeast absorbing the remains of L6. L8 destroys the 500 mb anticyclonic circulation to become the main Pacific feature by day 5.

Assessment scheme:

(i) Maintenance of the European 500 mb blocking ridge.

(ii) Treatment of L4.

(iii) Development of L7 and the 500 mb anticyclonic circulation at 60°N 180°W.

(iv) Development of L8 and the breakdown of the anticyclonic circulation.

Performance

(i) A good 500 mb block is maintained over Europe in about the correct position.

(ii) Development and tracking of L4 is good on the whole but it is filled rather slowly over Biscay and beyond.

(iii) L7 is well forecast throughout most of the period and the 500 mb circulation at 60°N 180°W is developed.

(iv) The development of L8 from day 2 onward is not indicated but the 500 mb anticyclonic circulation is weakened.

With the exception of (iv), on the whole a good forecast.

Statistical Verification

For each of the six forecasts, the verification package of computer programmes produced statistics in the following forms:

(a) Differences (Forecast minus actual) at 500 mb and 1000 mb.

(b) Differences (Persistence minus actual) at 500 mb and 1000 mb.

(c) Correlation coefficients between (a) and (b) at 500 mb and 1000 mb.

(c) Fourier analysis of difference fields (a) and (b) at 500 mb.

Table 1 shows the RMS differences and correlation coefficients as single values for each forecast for each day, for the area from 25° north to the North Pole.

For each of the six cases Hovmoeller diagrams including all wave numbers 1 to 16 for the actual situation and the forecast are included for the 500 mb level, at 49° north.

(1) 12Z 12.12.72

Although on day 1 this forecast has errors only slightly better than persistence, days 2 to 5 are good statistically. The Hovmoeller diagrams for the forecast and actual situations match very well both in the movement and position of features. The dominant wavenumber is 2 on days 1 and 2, changing to wavenumber 4 by day 4, and this is well illustrated. The overall impression is of a good forecast.

(2) 00Z 20.12.72

Statistically over the hemisphere this forecast is only a slight improvement over persistence on days 2 to 4, with errors being slightly worse than persistence on days 1 and 5. The forecast errors are in fact of similar magnitude to those in case (1) but persistence errors are considerably smaller.

On day 1 the dominant wavenumber is 3 and the Hovmoeller diagram for the actual situation shows this persisting for much of the period. However, the forecast loses this particularly in the region 90° west through the Greenwich meridian to 120° east, and shows a tendency towards wavenumber 1 from day 3 onwards.

This forecast is, therefore, only moderate.

(3) 00Z 22.12.72

This is undoubtedly the worst forecast of the set of six. The statistics indicate that the forecast gets steadily worse throughout the period, with very low correlation coefficients, and errors considerably larger than those obtained from persistence. Day 5 is particularly bad. The Hovmoeller diagrams start by matching reasonably well on day 1, but subsequently the forecast diagrams lose all except wavenumber 1, and are completely wrong in the sector 0°–120° west throughout the period.

(4) 00Z 11.1.73

This forecast is statistically poor on day 1, the errors being slightly worse than those from persistence, but subsequently improves to good by day 3, and maintains this standard to day 5. The Hovmoeller diagrams contain mainly a combination of wavenumbers 2 and 3, and maintain a good match throughout the period, apart from a small section between 30° east and 90° east where the forecast moves features steadily east,

when in fact they remain stationary after day 2. The overall description of a good forecast may be applied to this case.

(5) 12Z 12.1.73

The errors obtained during the first three days of this forecast appear to differ little from those obtained from persistence, but some improvement occurs on days 4 and 5. However, the combination of wavenumbers 2 and 3 in the Hovmoeller diagrams is well matched in the forecast until day 5 when some differences are evident, especially 0° - 90° west. A fairly good forecast overall.

(6) 00Z 14.1.73

This forecast too is poor statistically on day 1, again being slightly worse than persistence. A subsequent improvement occurs on days 2 to 4, but day 5 shows a deterioration. The Hovmoeller diagrams for actual and forecast situations match fairly well, apart from the section 60° west across the Greenwich meridian to about 90° east which shows some differences. This case may be described as generally fairly good.

Case	Forecast Verification Day	Day 1			Day 2			Day 3			Day 4			Day 5		
		RMS	PER	COR	RMS	PER	COR	RMS	PER	COR	RMS	PER	COR	RMS	PER	COR
	12.12.72	7.25	8.11	0.630	9.12	12.10	0.711	10.62	15.64	0.703	12.08	18.70	0.751	13.87	19.33	0.691
	20.12.72	7.37	6.85	0.578	9.31	10.77	0.626	9.73	11.96	0.737	11.22	12.04	0.731	13.97	12.38	0.617
	22.12.72	7.57	6.81	0.611	10.02	8.10	0.512	10.62	9.76	0.492	11.93	10.85	0.454	15.88	11.20	0.230
	11. 1.73	7.81	7.44	0.547	9.69	11.15	0.643	9.97	12.97	0.691	10.91	14.10	0.688	11.28	15.10	0.711
	12. 1.73	7.21	7.90	0.712	10.37	9.27	0.633	9.90	10.59	0.651	9.75	12.52	0.680	12.11	14.56	0.665
	14. 1.73	7.52	7.37	0.525	8.31	9.52	0.661	9.06	11.67	0.692	10.05	11.92	0.715	12.24	12.67	0.631

TABLE 1

References

Saker N J	1975	An 11 Layer General Circulation Model Met O 20. Technical Note No II/30.
Druyen L M, Somerville R C J and Quirk W J	1975	Extended-Range Forecasts with the GISS Model of the Global Atmosphere. Monthly Weather Review (American Meteorological Society) 103, pp 779-795.
Druyen L M	1974	Short Range Forecasts with the GISS Model of the Global Atmosphere. Monthly Weather Review 102, pp 269-279.
Somerville R C J et al	1974	The GISS Model of the Global Atmosphere Journal of Atmospheric Sciences 31, pp 84-117

Figure 1.1

EXPERIMENT TIME = 0000H12 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 12/12/72 12Z

Figure 1.2

EXPERIMENT TIME = D000H12 PMSL
CONTOUR INTERVAL = 4.00 MB

ACTUAL 12/12/72 12Z

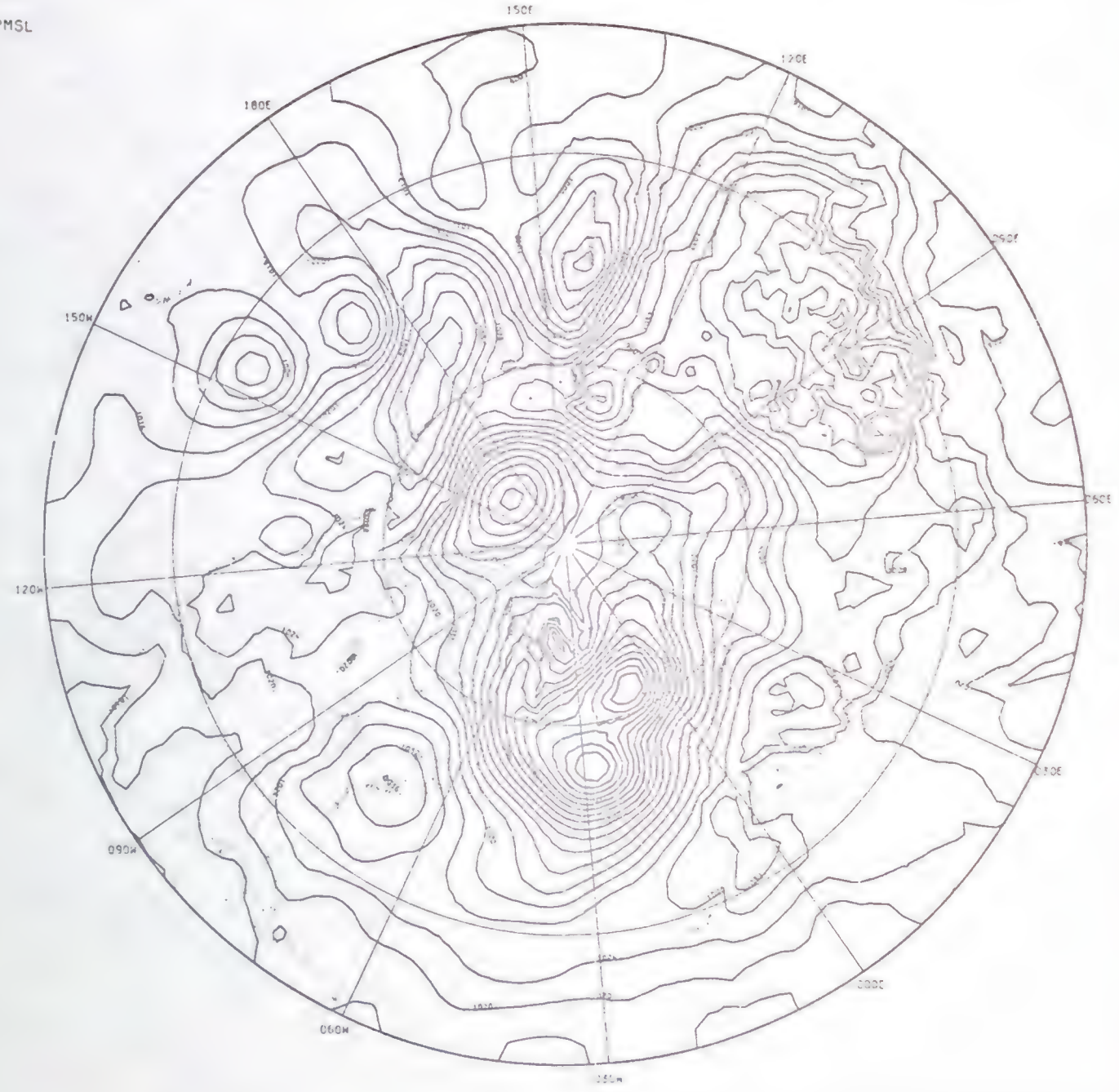


Figure 1.3

EXPERIMENT TIME = 0003H12 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 15/12/72 12Z

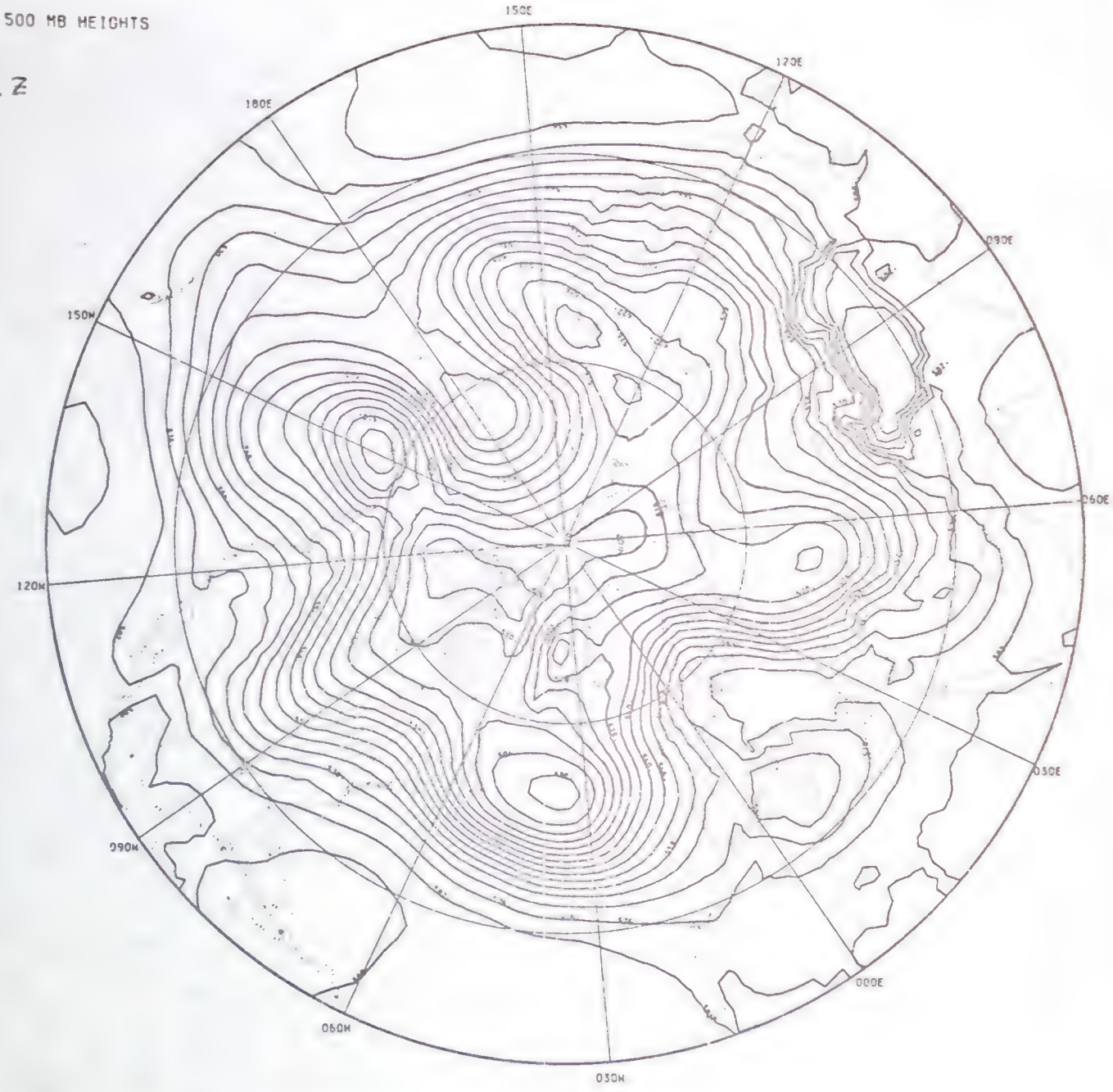


Figure 1.4.

EXPERIMENT TIME = D003H12 PMSL
CONTOUR INTERVAL = 4.00 MB

ACTUAL 15/12/72 12Z

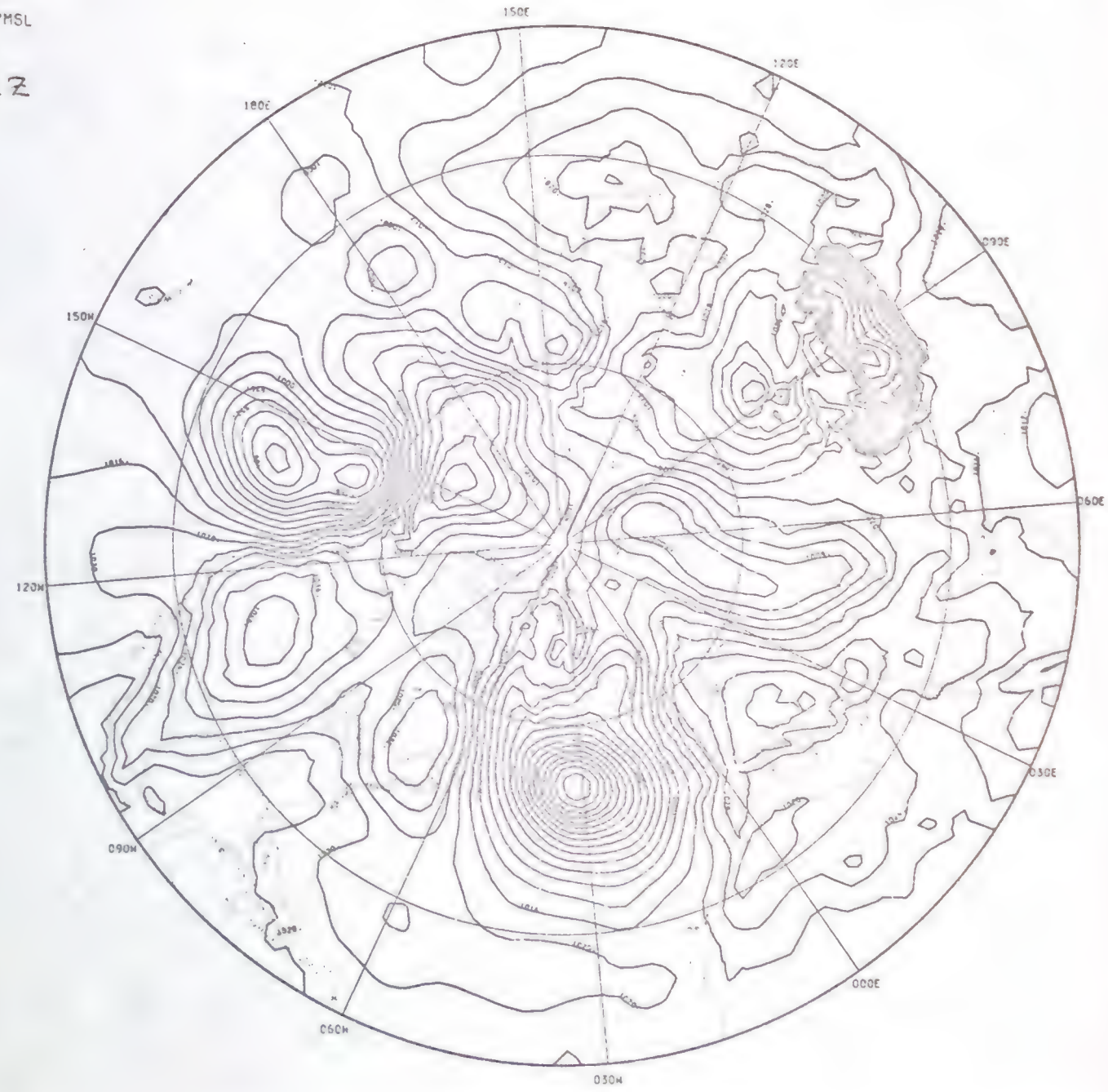


Figure 1.5

EXPERIMENT TIME = D003H12 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

FORECAST FOR 15/12/72 12Z
FROM DATA 12/12/72 12Z

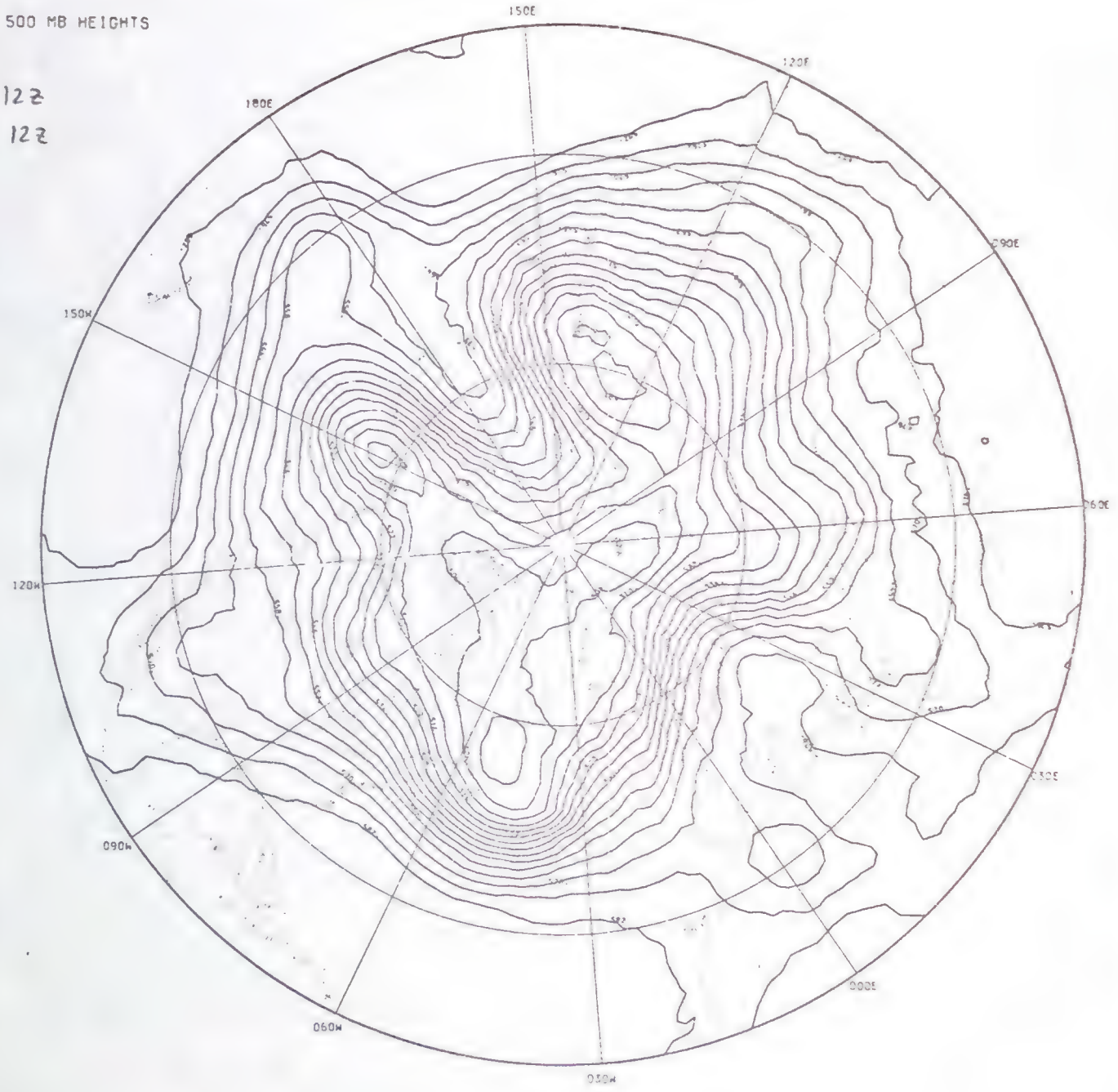


Figure 1.6

EXPERIMENT TIME = 0003H12 PMSL
CONTOUR INTERVAL = 4.00 MB

FORECAST FOR 15/12/72 12Z

FROM DATA 12/12/72 12Z

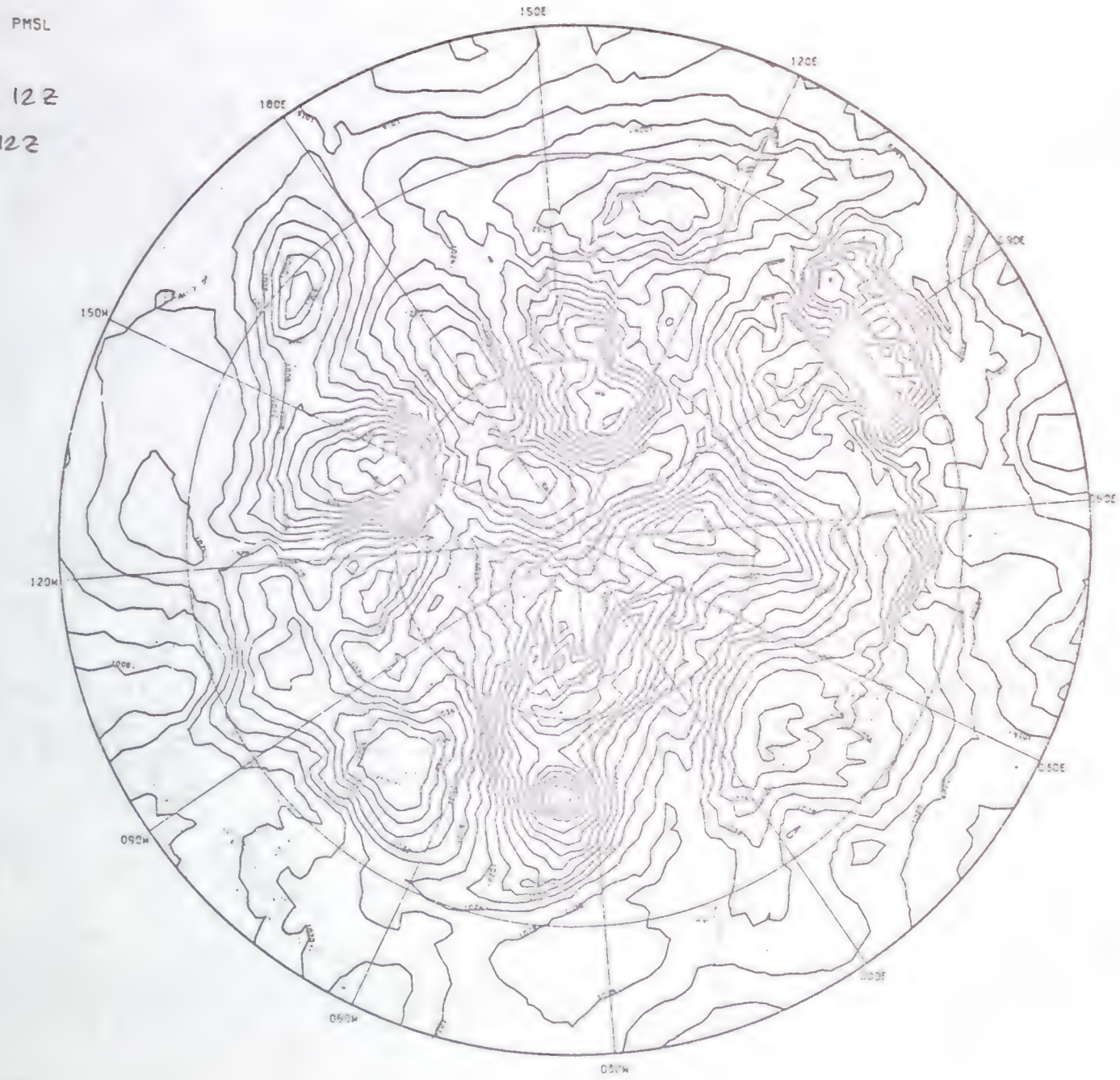


Figure 1.7 NCAR 5-DAY ACTUALS - D000H12 = 12Z DECEMBER 12TH 1972

MEAN OF WAVE NOS 1 - 16 AT LATITUDE = 49

Figure 1.8

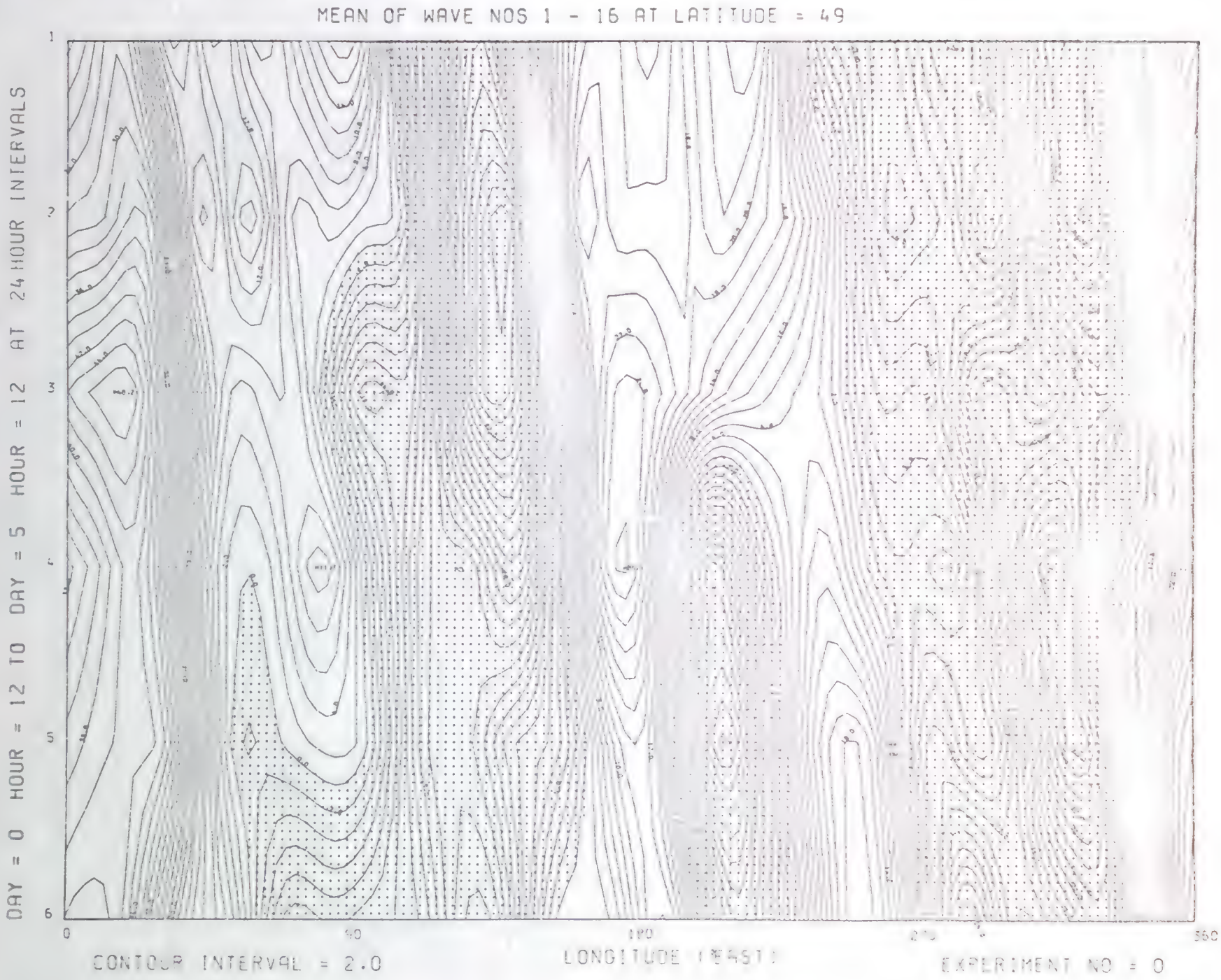

NCAR 5-DAY FORECAST - D0000H12 = 12Z. DECEMBER 12TH 1972
MEAN OF WAVE NOS 1 - 16 AT LATITUDE = 49
DAY = 0 HOUR = 12 TO DAY = 5 HOUR = 12 AT 24 HOUR INTERVALS
1
2
3
4
5
6
0
90
180
270
360
CONTOUR INTERVAL = 2.0
LONGITUDE (EAST)
EXPERIMENT NO = 0

Figure 2.1

EXPERIMENT TIME = 0000H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 20/12/72 00Z

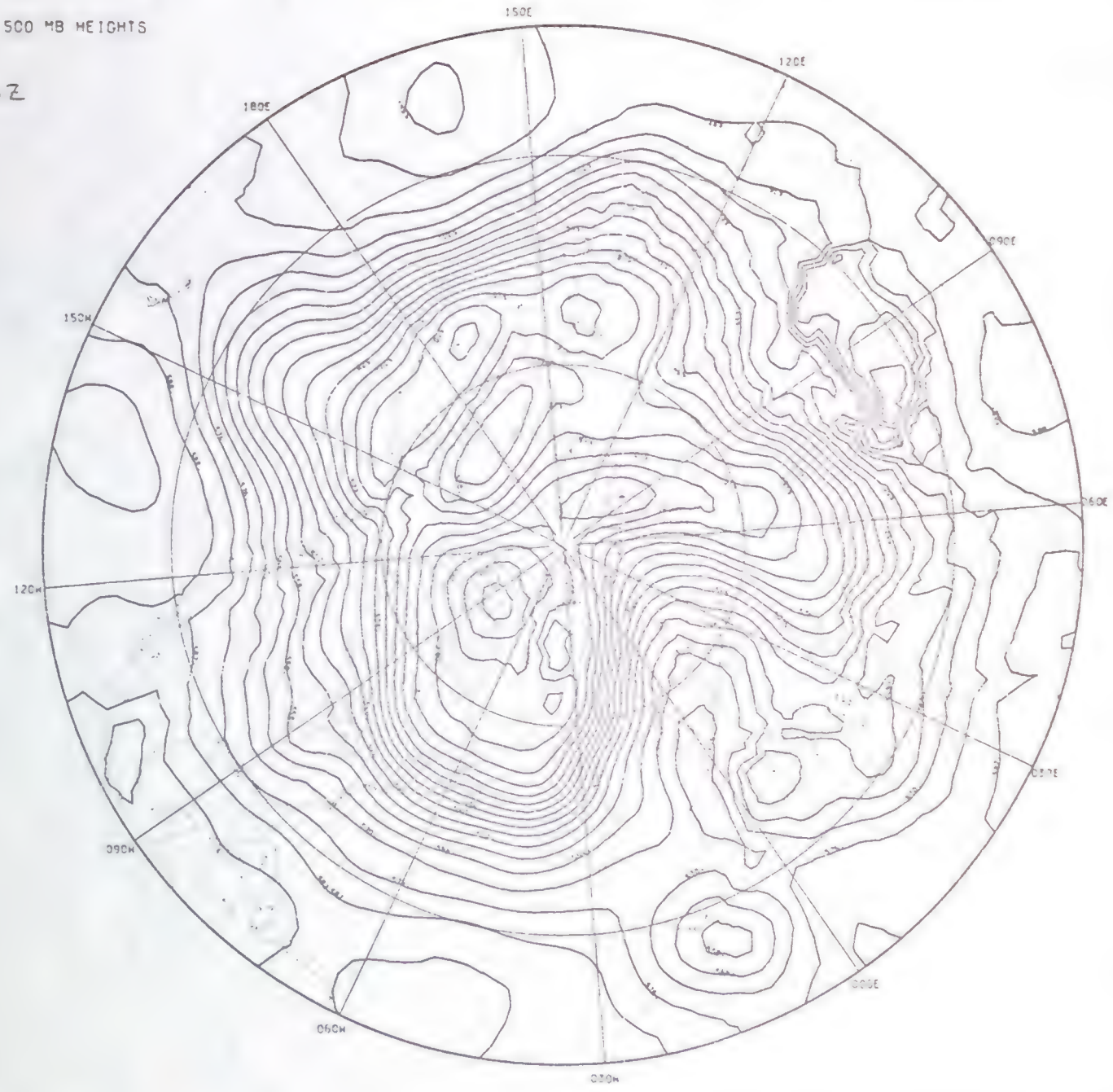


Figure 2.2

EXPERIMENT TIME = 0000H00 PMSL
CONTOUR INTERVAL = 4.00 MB

ACTUAL 20/12/72 00Z

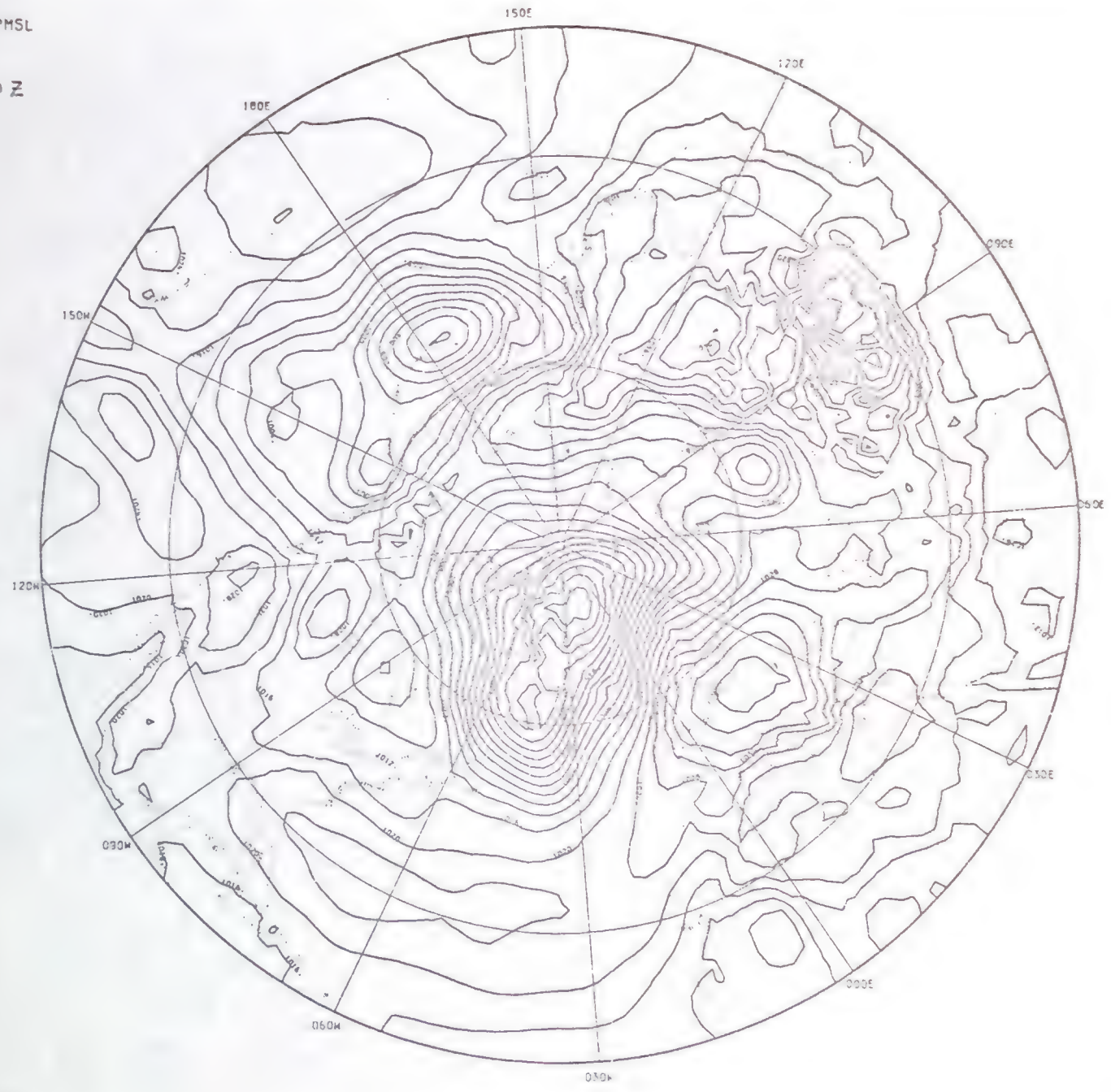


Figure 2.3

EXPERIMENT TIME = D011H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 23/12/72 00Z

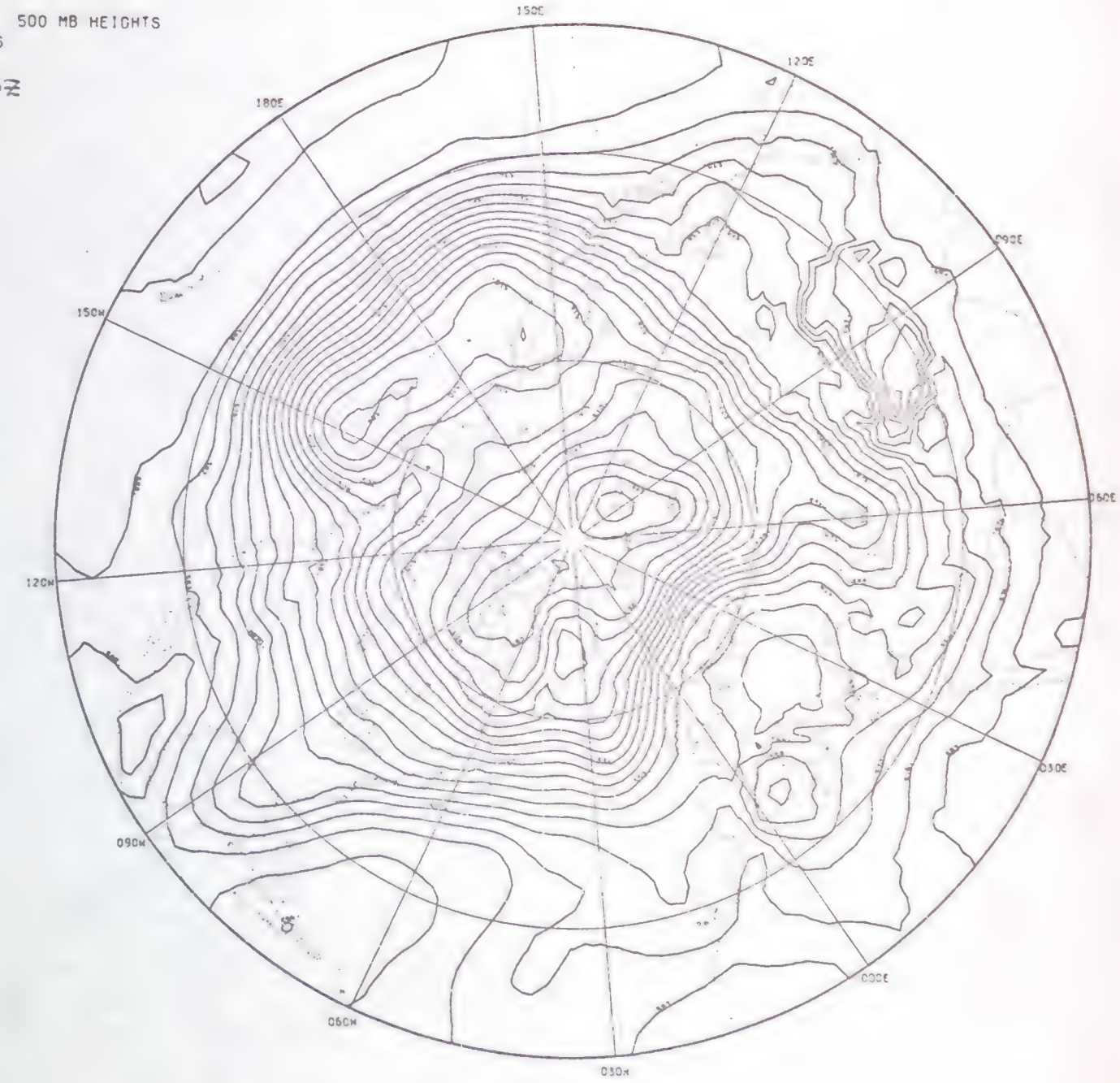


Figure 2.4

EXPERIMENT TIME = D011H00 PMSL
CONTOUR INTERVAL = 4.00 MB

ACTUAL 23/12/72 00Z

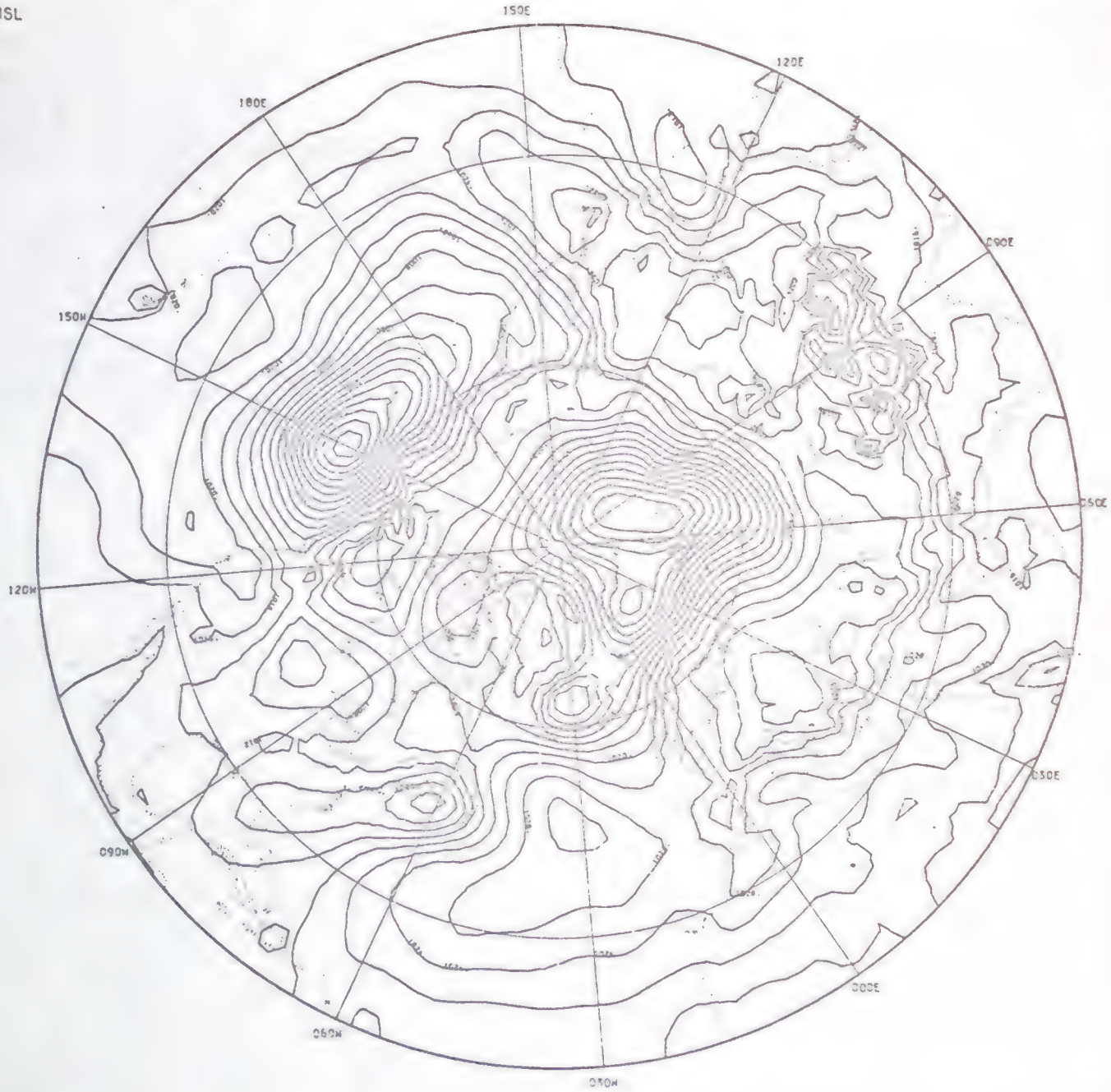


Figure 2.5

EXPERIMENT TIME = 0003H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

FORECAST FOR 23/12/72 00Z
FROM DATA 20/12/72 00Z

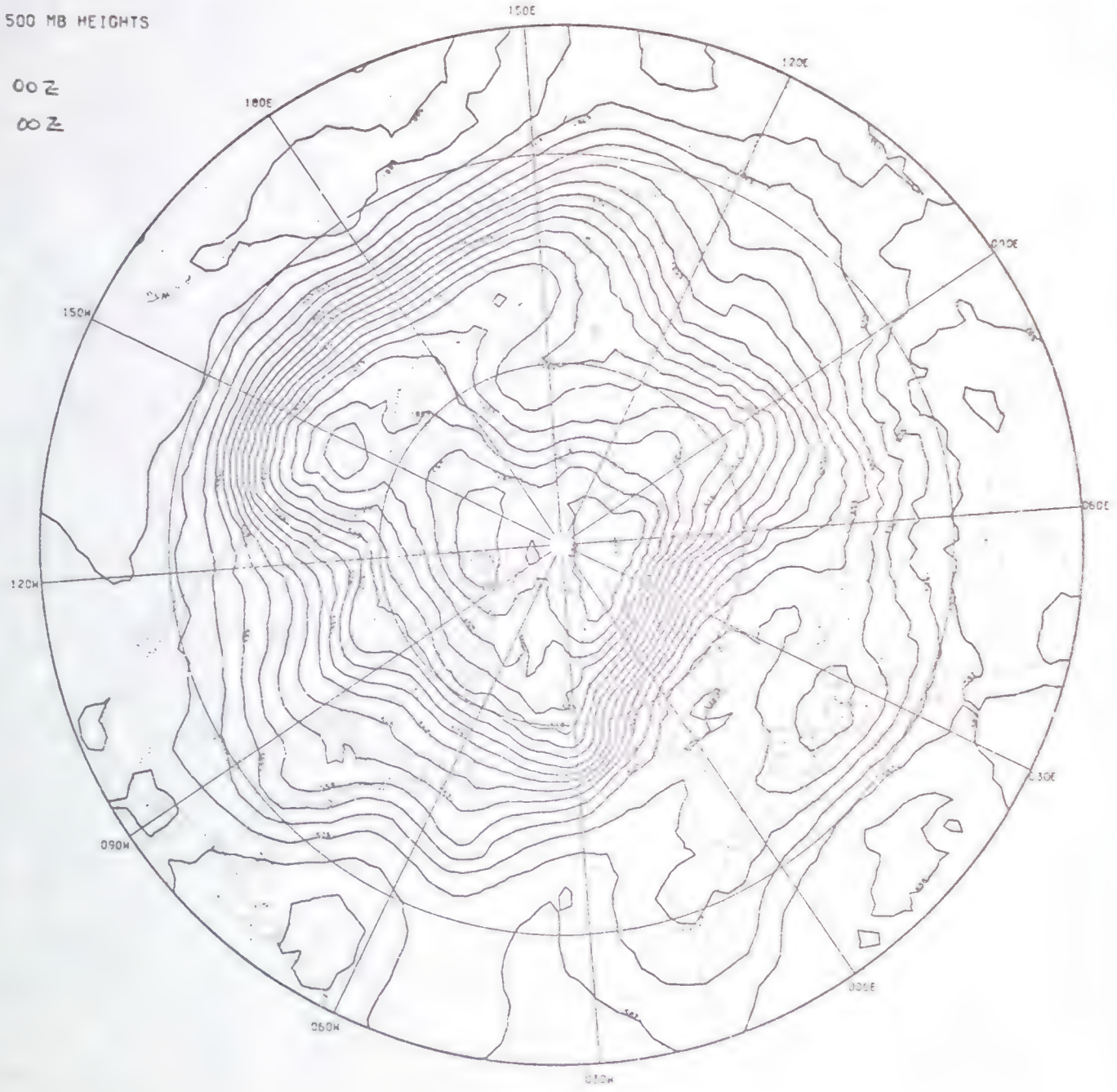


Figure 2.6

EXPERIMENT TIME = 0003H00 PMSL
CONTOUR INTERVAL = 4.00 MB

FORECAST FOR 23/12/72 00Z
FROM DATA 20/12/72 00Z

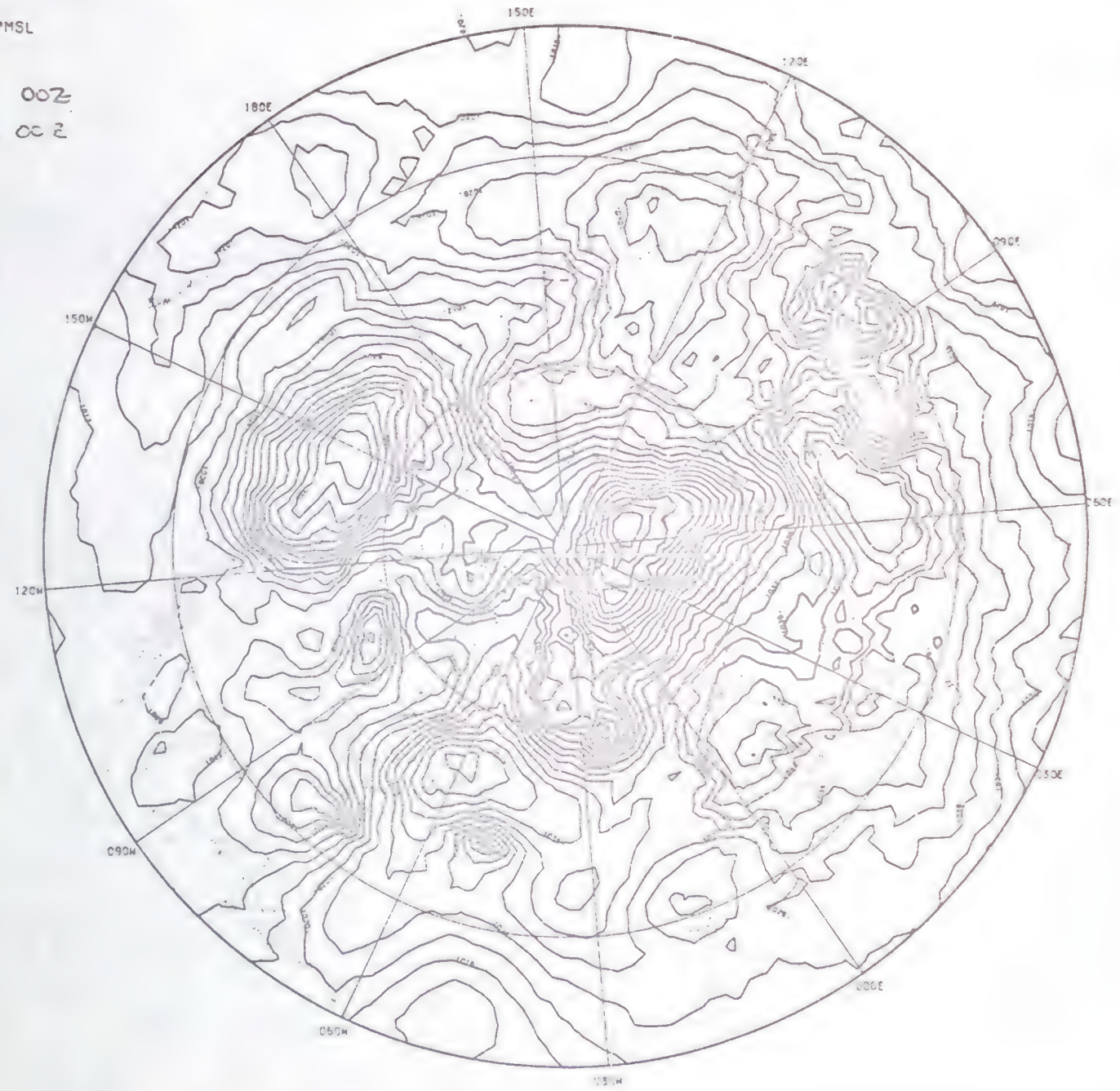


Figure 2.7

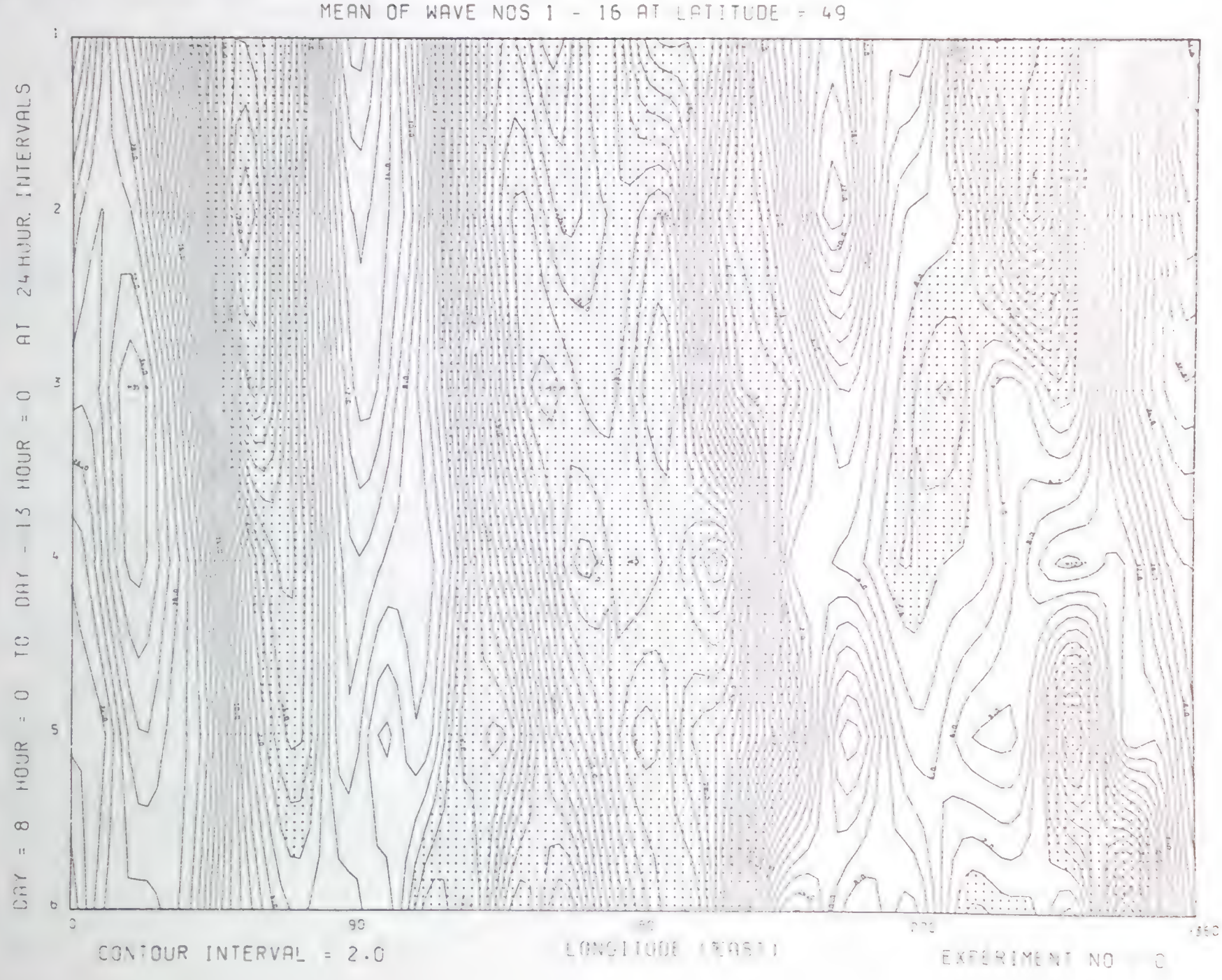

NCAR 5-DAY ACTUALS - 0000H00 = 00Z DECEMBER 20TH 1972
MEAN OF WAVE NOS 1 - 16 AT LATITUDE = 49
DAY = 8 HOUR = 0 TO DAY - 13 HOUR = 0 AT 24 HOUR INTERVALS
1
2
3
4
5
6
0
90
180
270
360
CONTOUR INTERVAL = 2.0
LONGITUDE (EAST)
EXPERIMENT NO - C

Figure 2.8 NCAR 5-DAY FORECAST - D000H00 = 00Z DECEMBER 20TH 1972

Figure 3.1

EXPERIMENT TIME = DOCOHOO 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 22/12/72 00Z

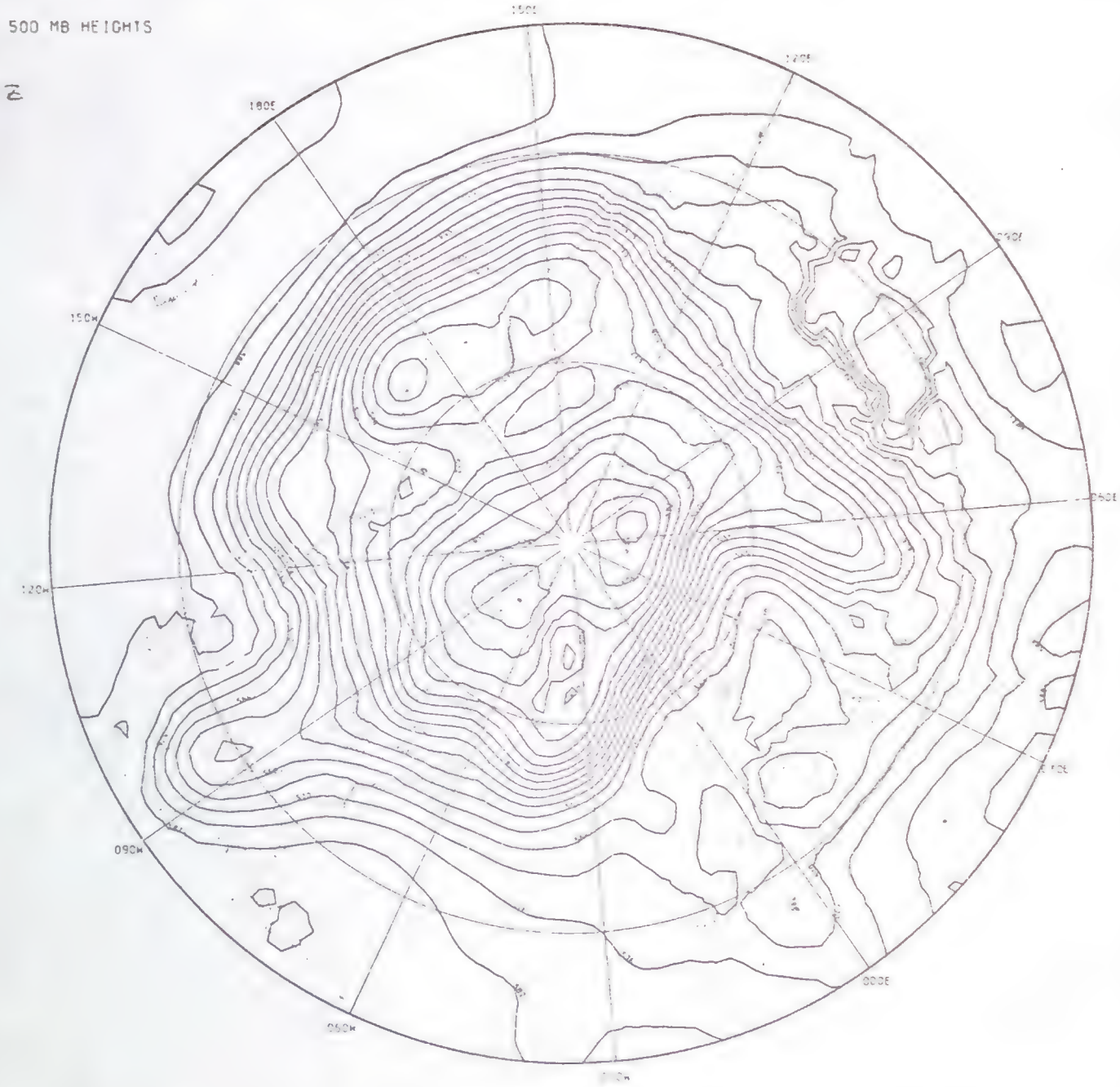


Figure 3.2

EXPERIMENT TIME = 0000H00 PMSL
CONTOUR INTERVAL = 4.00 MB

ACTUAL 22/12/72 00Z

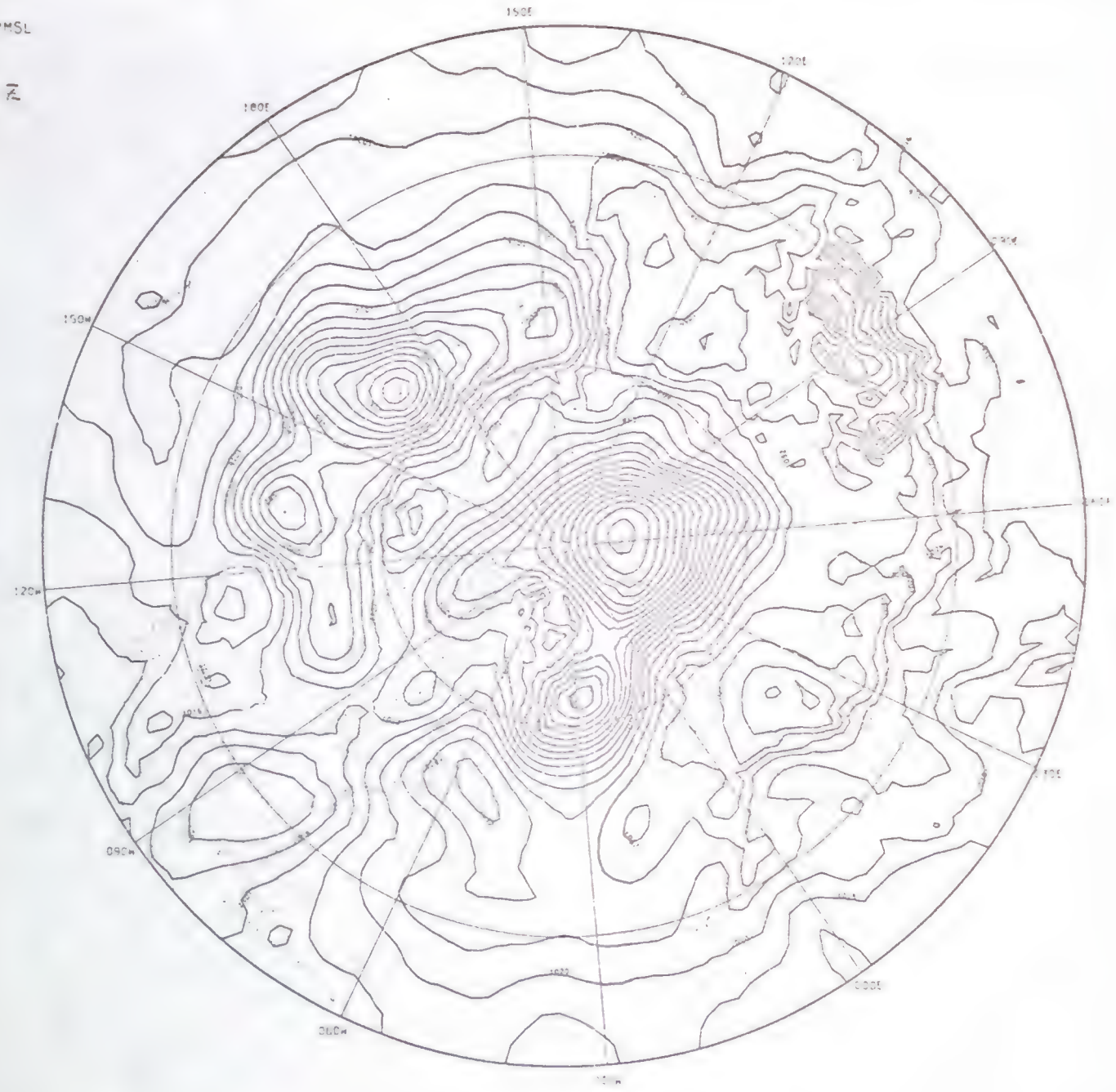


Figure 3.3

EXPERIMENT TIME - 00:12H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 25/12/72 00Z

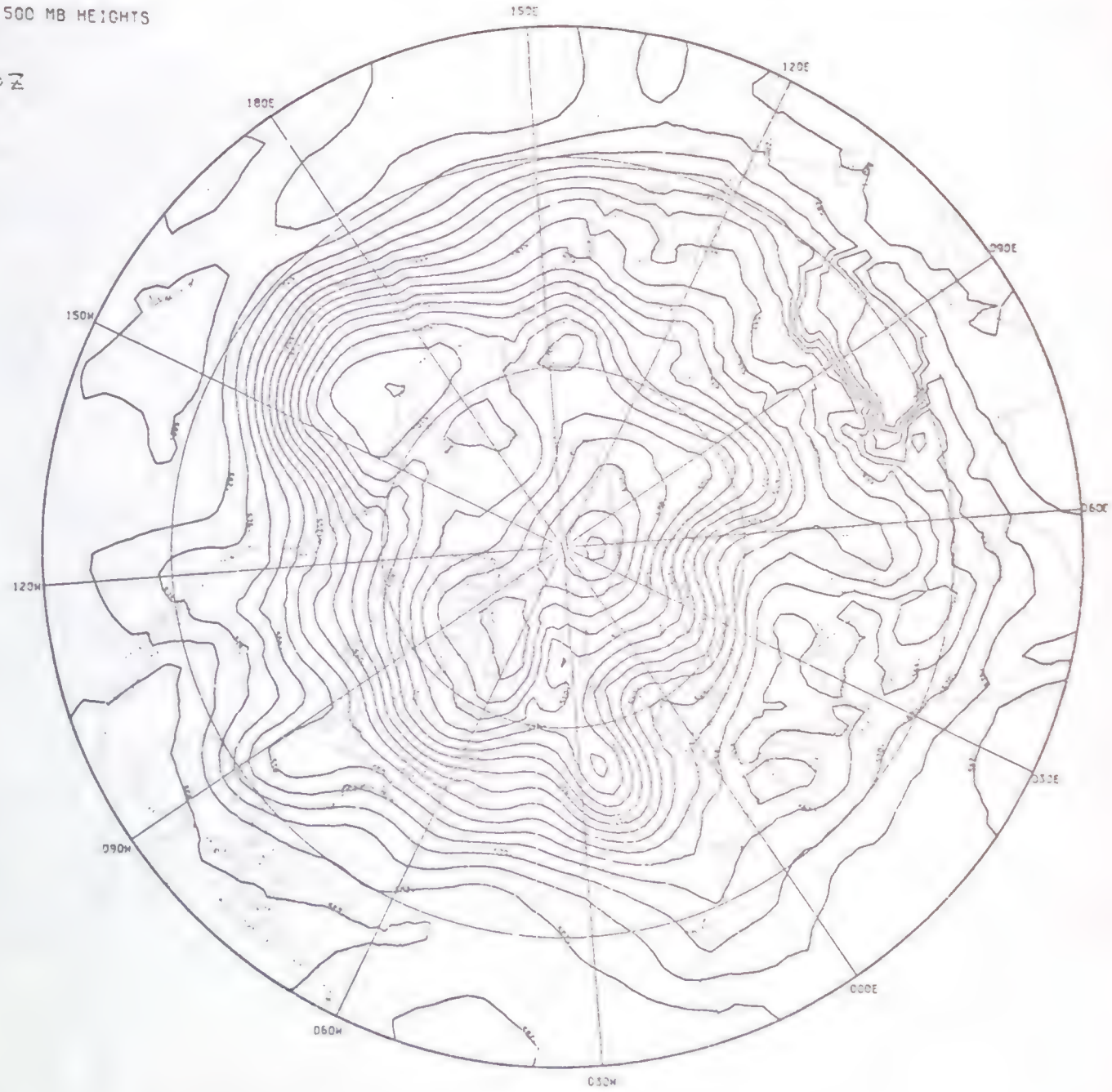


Figure 34

EXPERIMENT TIME = D013H00 PMSL
CONTOUR INTERVAL = 4.00 MB

ACTUAL 25/12/72 00Z

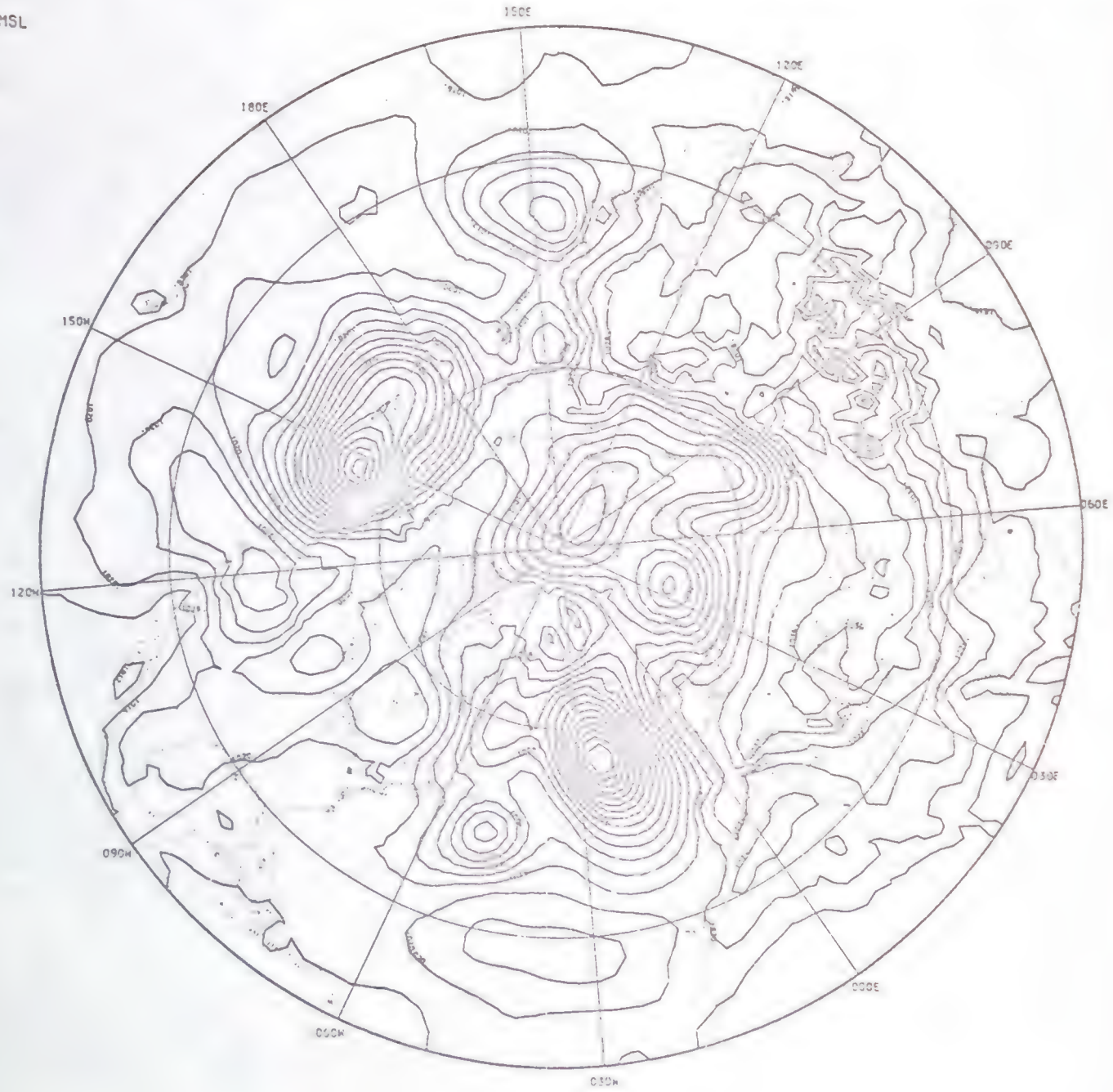


Figure 3.5

EXPERIMENT TIME = D003H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

FORECAST FOR 25/12/72 00Z
FROM DATA 22/12/72 00Z

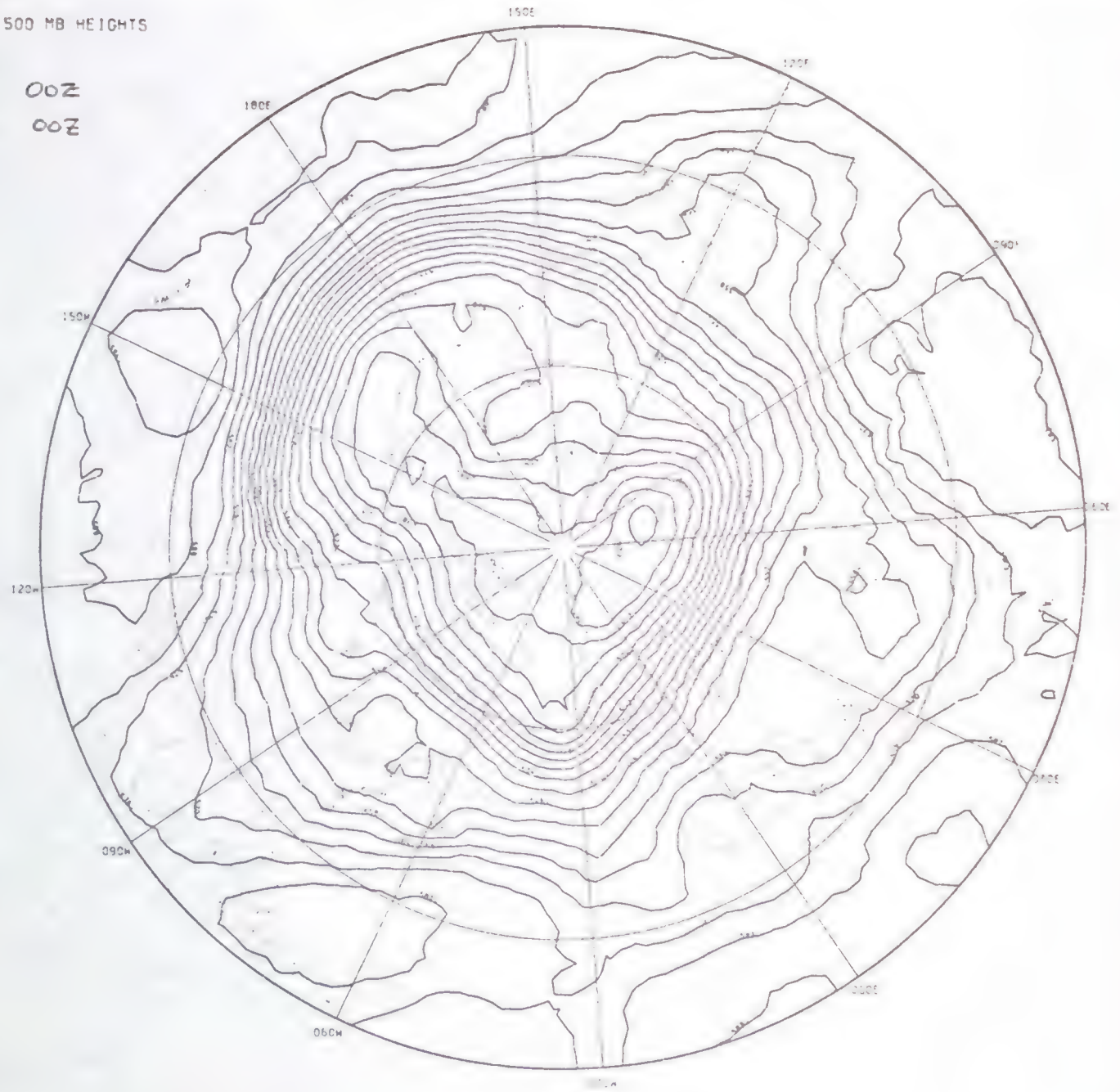


Figure 3.6

EXPERIMENT TIME = D003H00 PMSL
CONTOUR INTERVAL = 4.00 MB

FORECAST FOR 25/12/72 00Z
FROM DATA 22/12/72 00Z

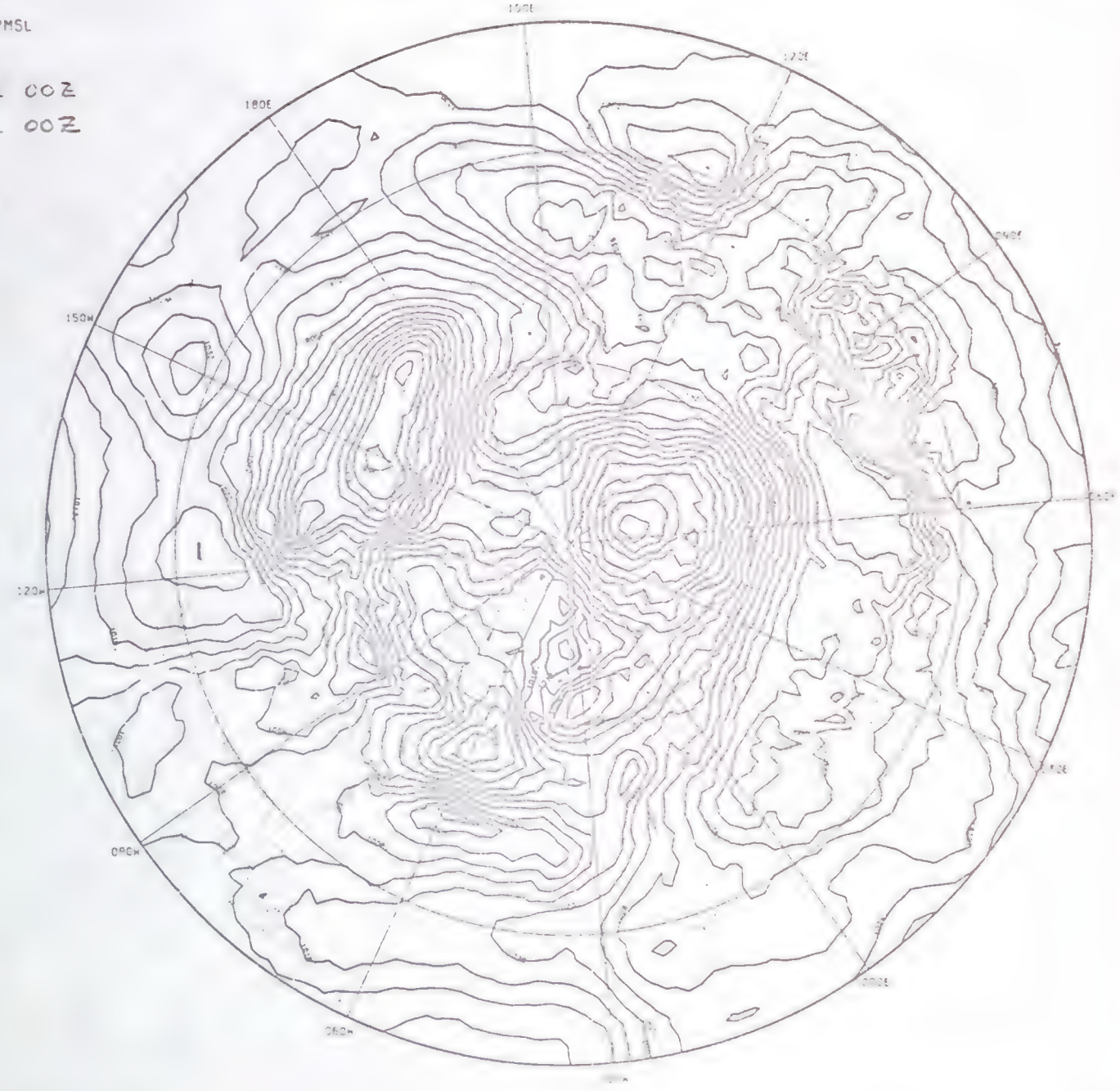


Figure 3.7 NCAR 5-DAY ACTUALS - D000H00 = 00Z DECEMBER 22ND 1972

MEAN OF WAVE NOS 1 - 16 AT LATITUDE = 49

CONTOUR INTERVAL = 2.0

EXPERIMENT NO 40

Figure 3.8 NCAR 5-DAY FORECAST - D000H00 = 00Z DECEMBER 22ND 1972

MEAN OF WAVE NOS 1 - 16 AT LATITUDE 40

CONTOUR INTERVAL = 2.0

LONGITUDE (EAST)

EXPERIMENT NO - 0

Figure 4.1

EXPERIMENT TIME = D000H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 11/1/73 00Z

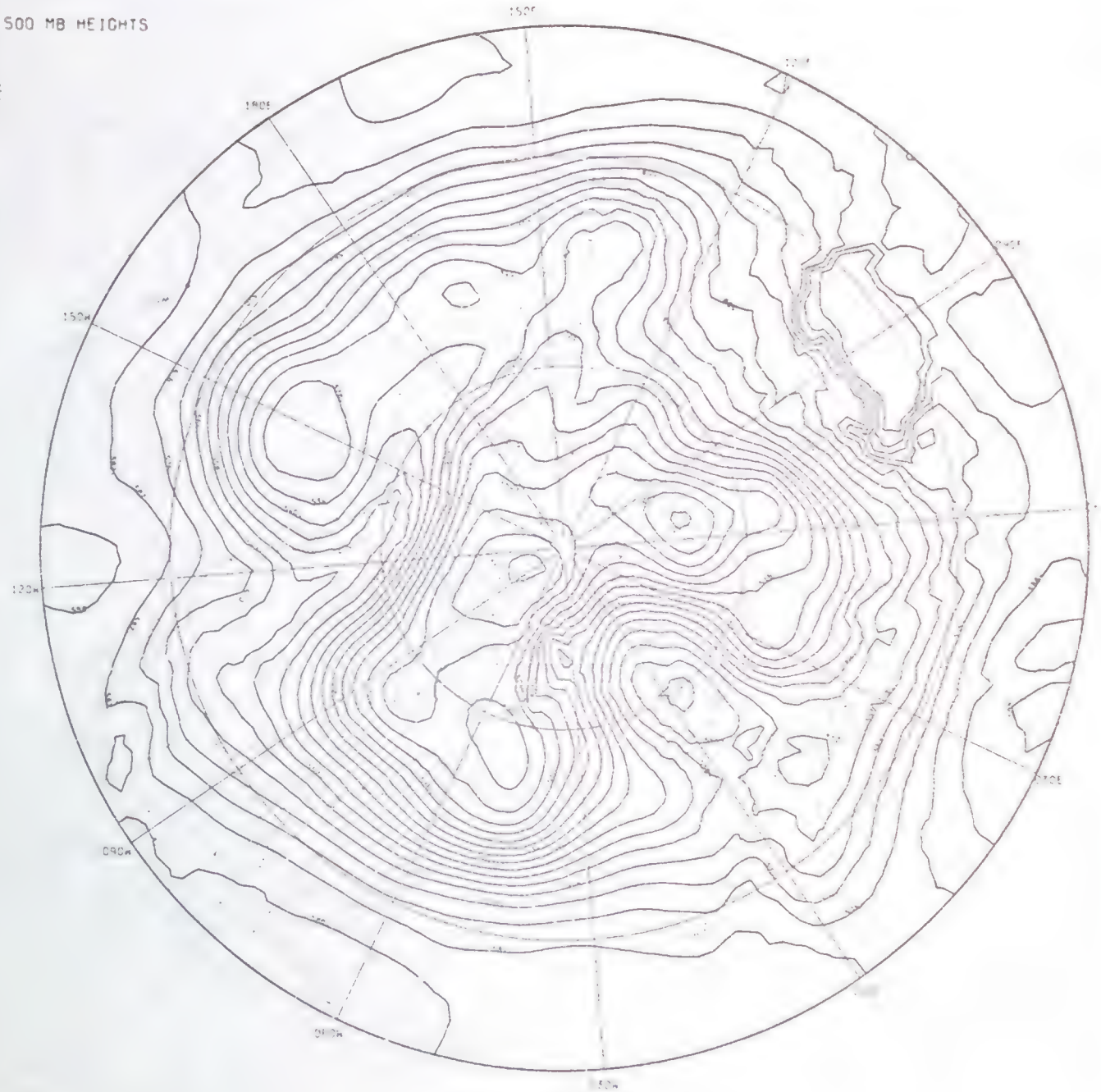


Figure 4.2

EXPERIMENT TIME = D000H00 PMSL
CONTOUR INTERVAL = 4.00 MB

ACTUAL 11/1/73 00Z

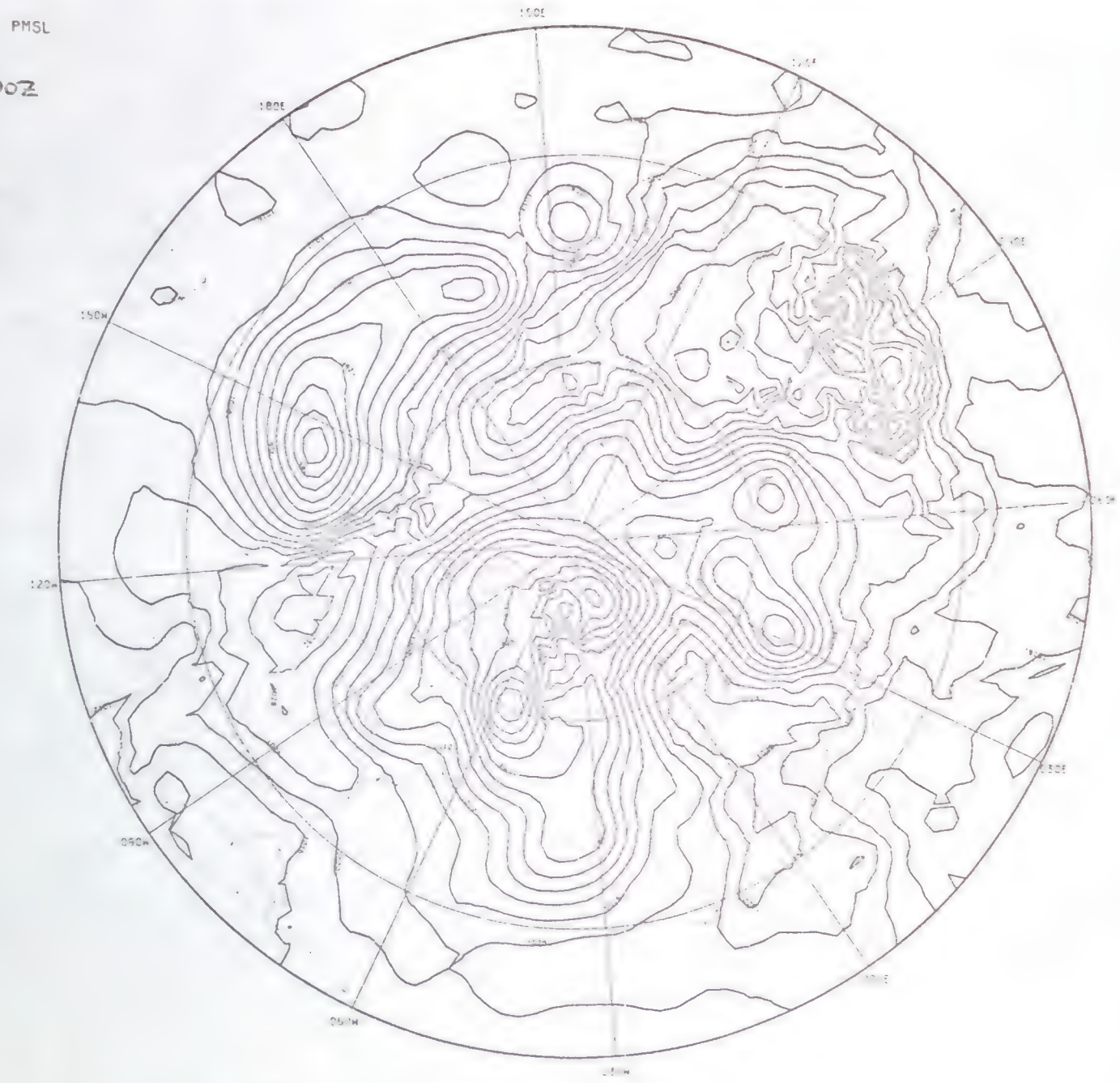


Figure 4.3

EXPERIMENT TIME = D003H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 14/1/73 00Z

Figure 4.4

EXPERIMENT TIME = D003H00 PMSL
CONTOUR INTERVAL = 4.00 MB

ACTUAL 14/1/73 00Z

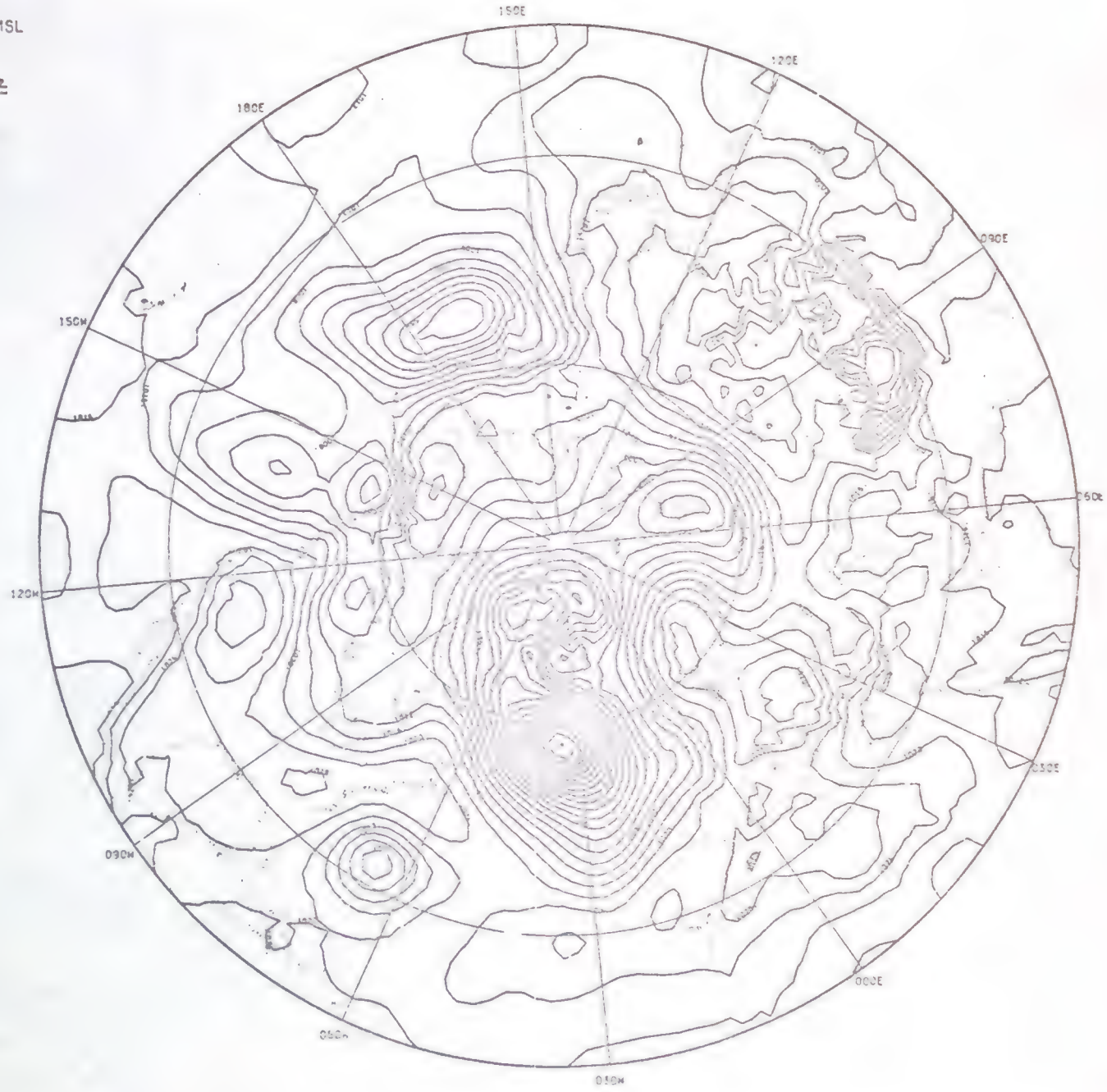


Figure 4.5

EXPERIMENT TIME = D003H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

FORECAST FOR 14/1/73 00Z
FROM DATA 11/1/73 00Z

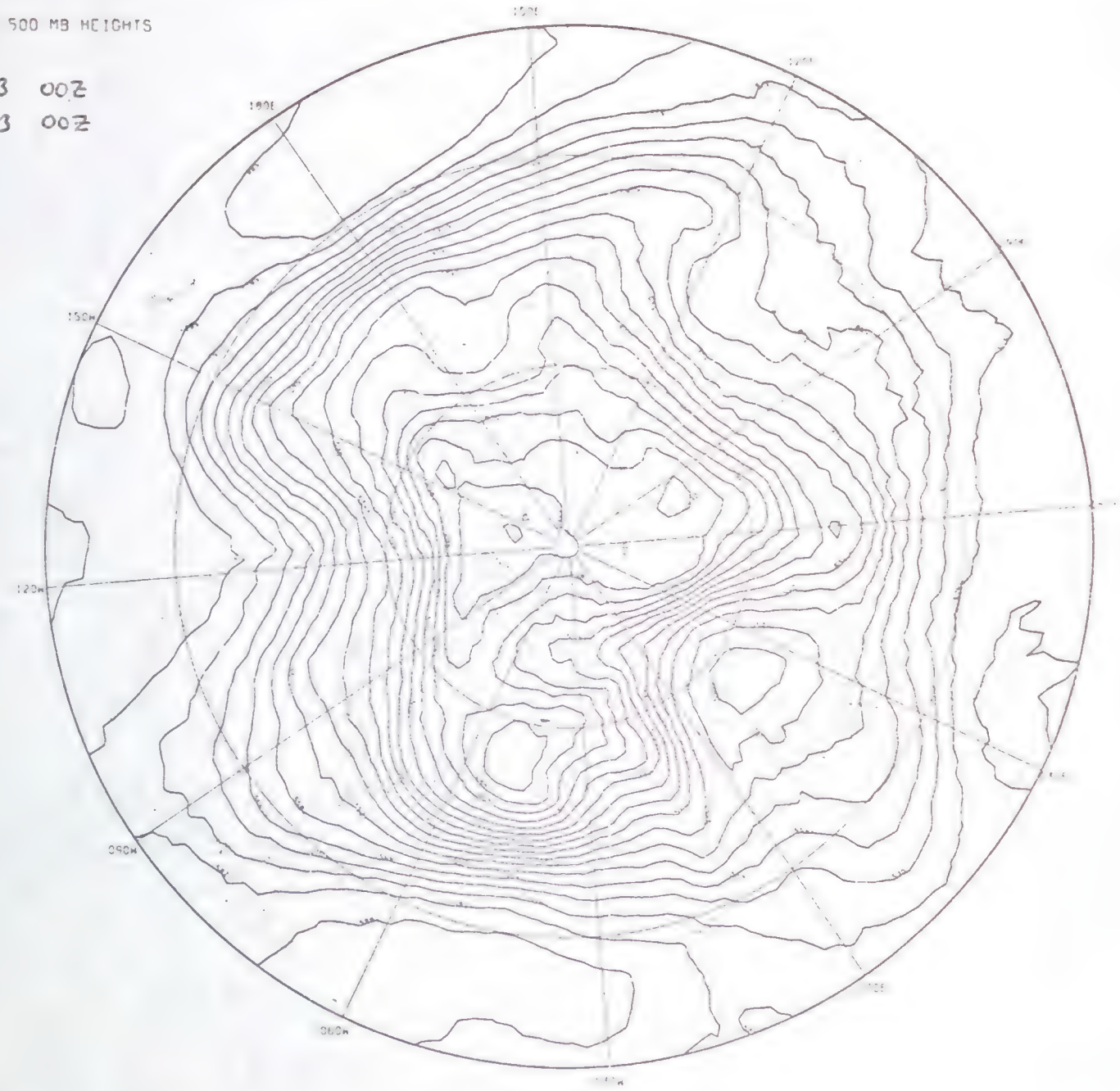


Figure 4.6

EXPERIMENT TIME = D003H00 PMSL
CONTOUR INTERVAL = 4.00 MB

FORECAST FOR 14/1/73 00Z
FROM DATA 11/1/73 00Z

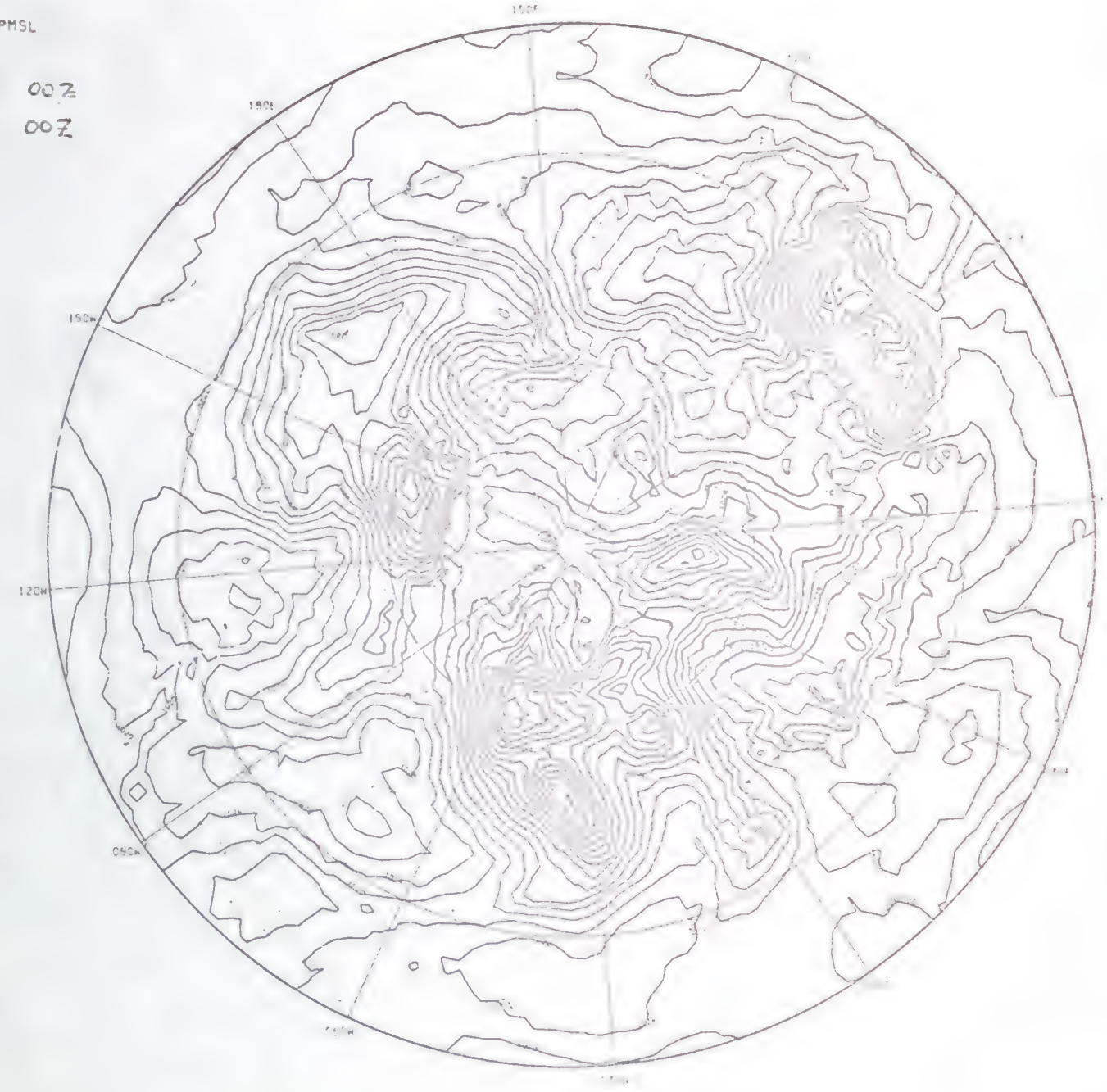


Figure 4.7 NCAR 5-DAY ACTUALS - 0000H00 = 00Z JANUARY 11TH 1973

Figure 4.8 NCAR 5-DAY FORECAST - DOOOHOO = OOZ JANUARY 11THD 1973

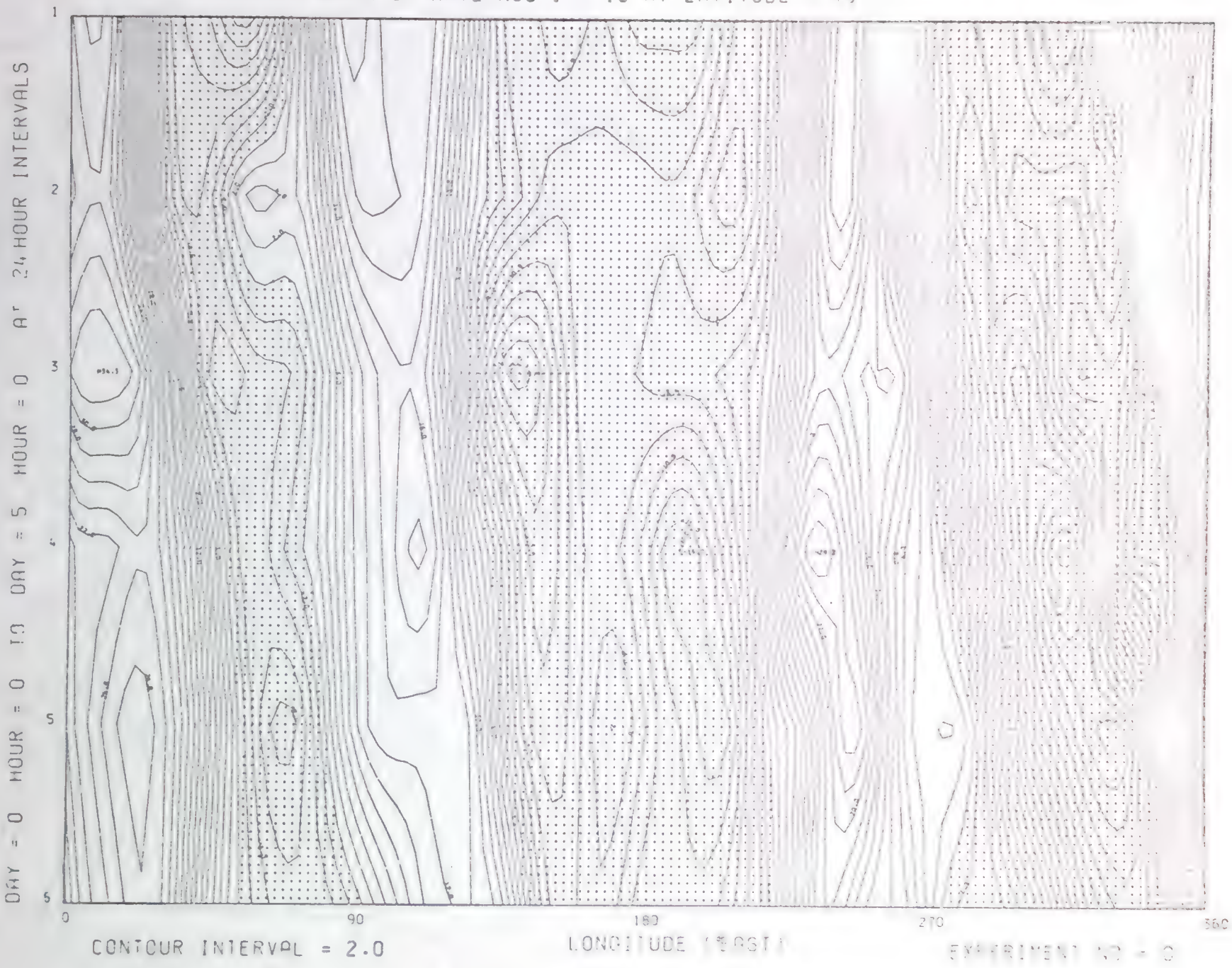


Figure 5.1

EXPERIMENT TIME = 0000H12 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 12/1/73 12Z

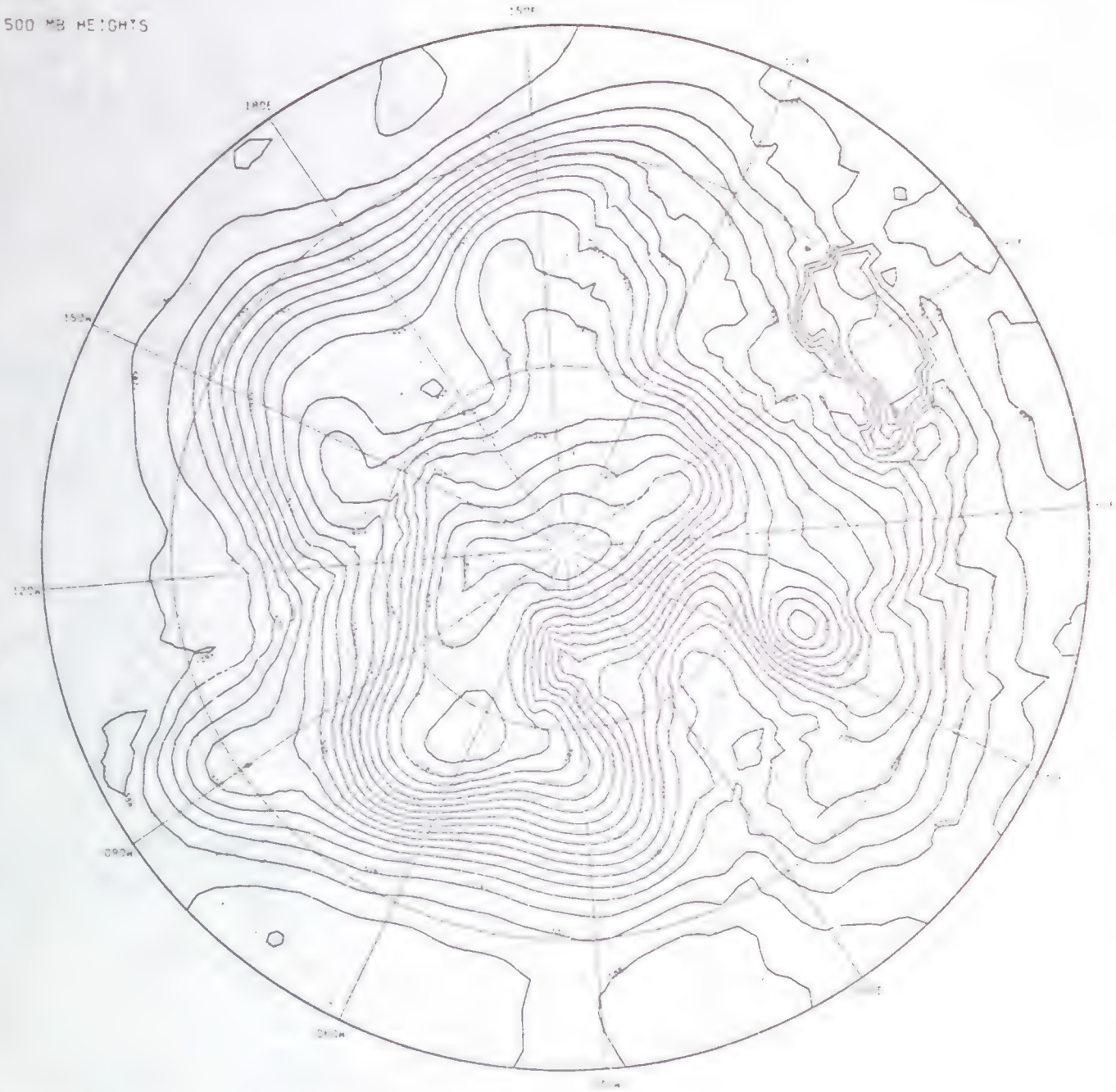


Figure 5.2

EXPERIMENT TIME - 0000H12 PMSL
CONTOUR INTERVAL - 4.00 MB

ACTUAL 12/1/73 12Z

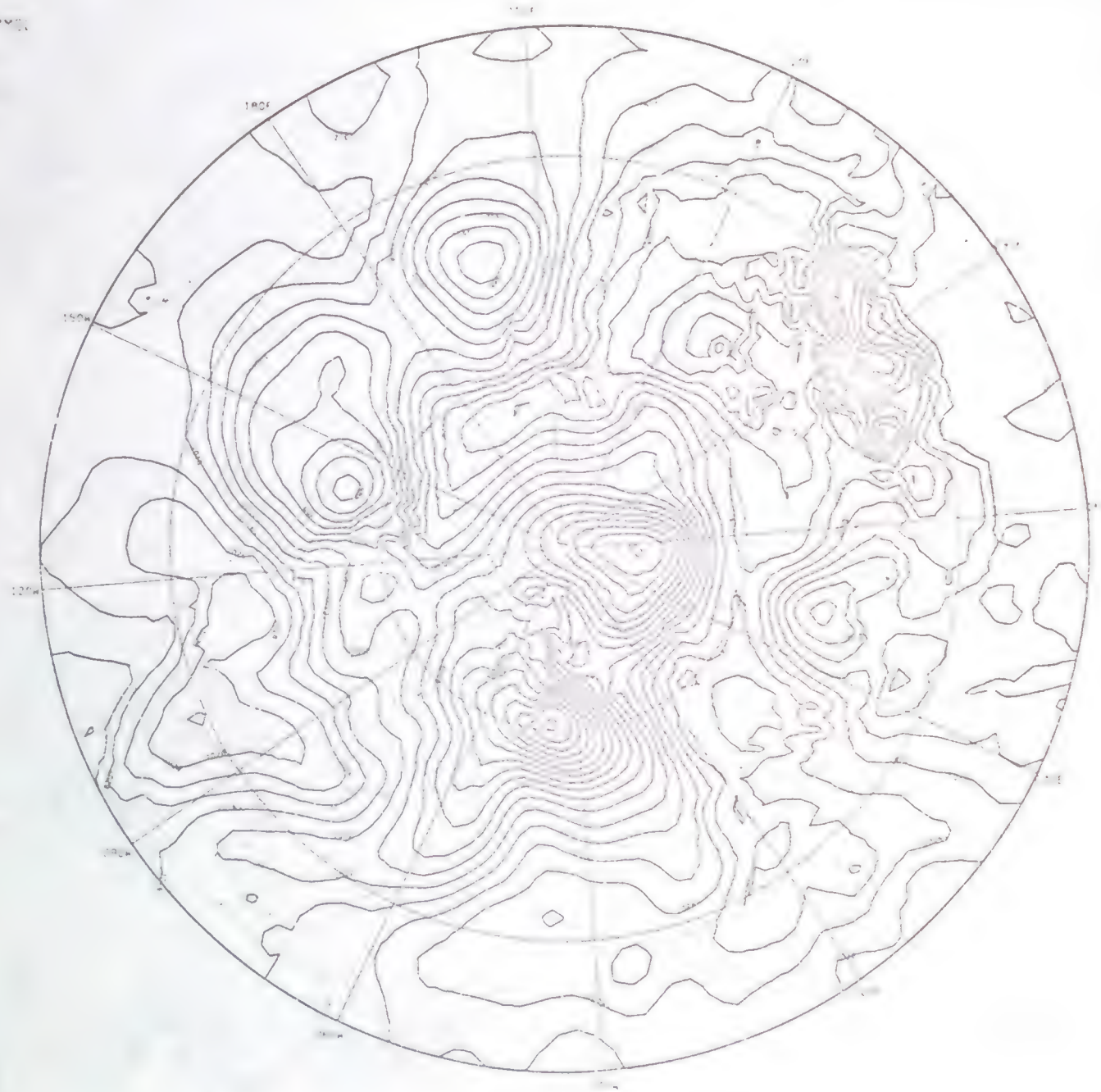


Figure 5.3

EXPERIMENT TIME = D004H12 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 15/1/73 12Z

Figure 5.4

EXPERIMENT TIME = 0004H12 PMSL
CONTOUR INTERVAL = 4.00 MB

ACTUAL 15/1/73 12Z

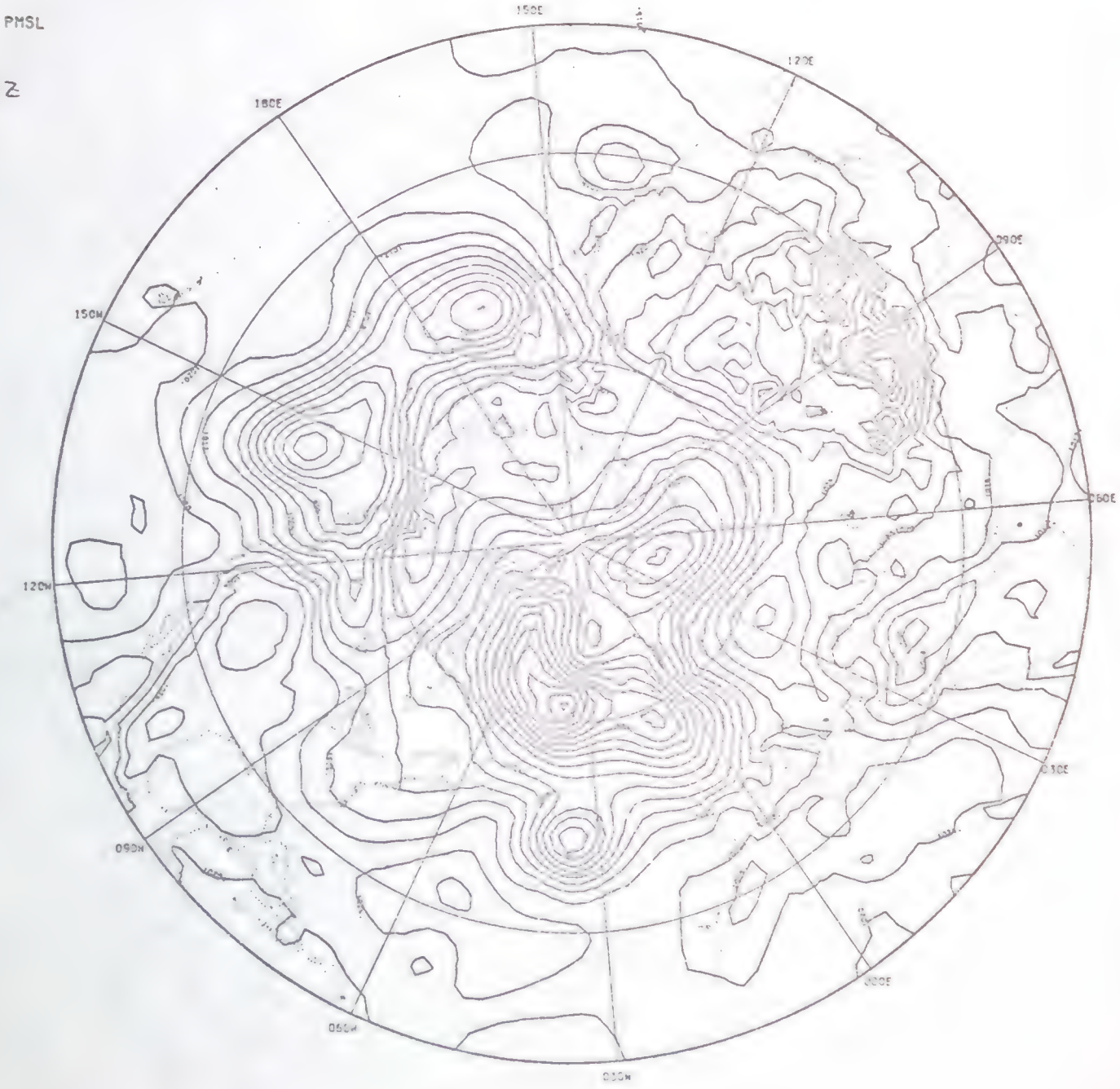


Figure 5.5

EXPERIMENT TIME = D003H12 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

FORECAST FOR 15/1/73 12Z
FROM DATA 12/1/73 12Z

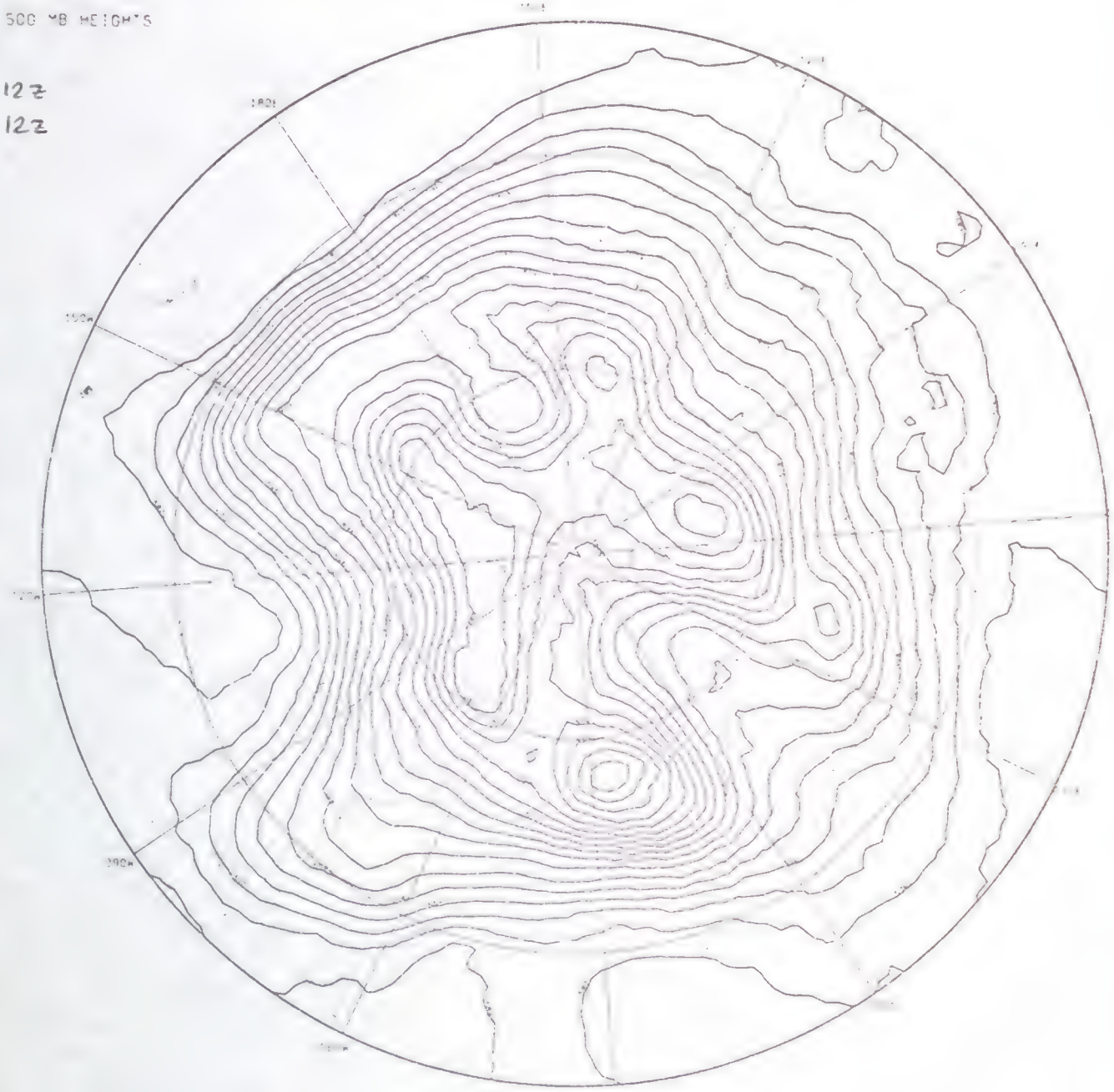


Figure 5.6

EXPERIMENT TIME = 0003H12 PMSL
CONTOUR INTERVAL = 4.00 MB

FORECAST FOR 15/1/73 12Z
FROM DATA 12/1/73 12Z

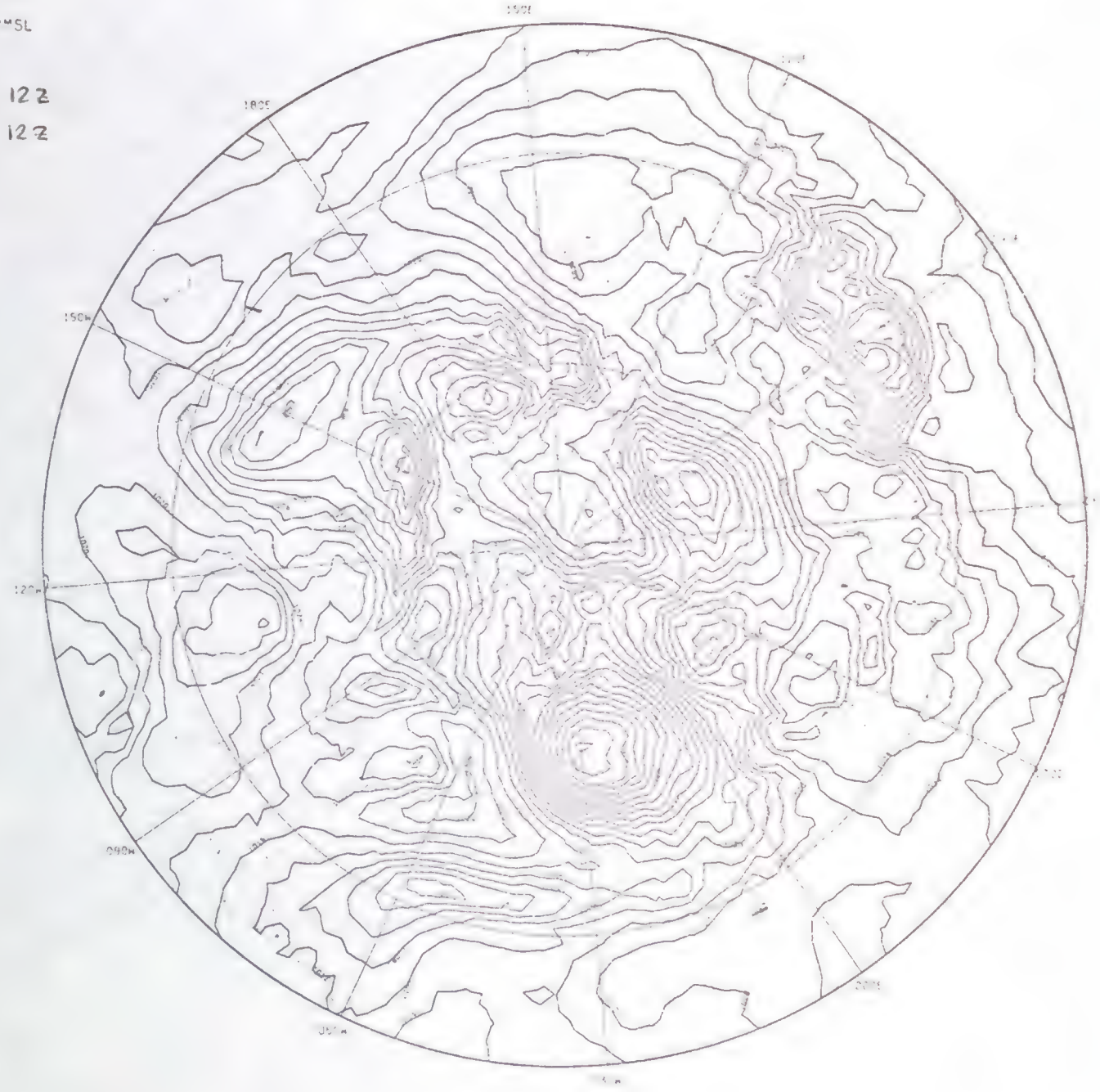


Figure 5.7

NCAR 5-DAY ACTUALS - D000H12 = 12Z JANUARY 12TH 1973

MEAN OF WAVE NOS 1 - 16 AT LATITUDE = 49

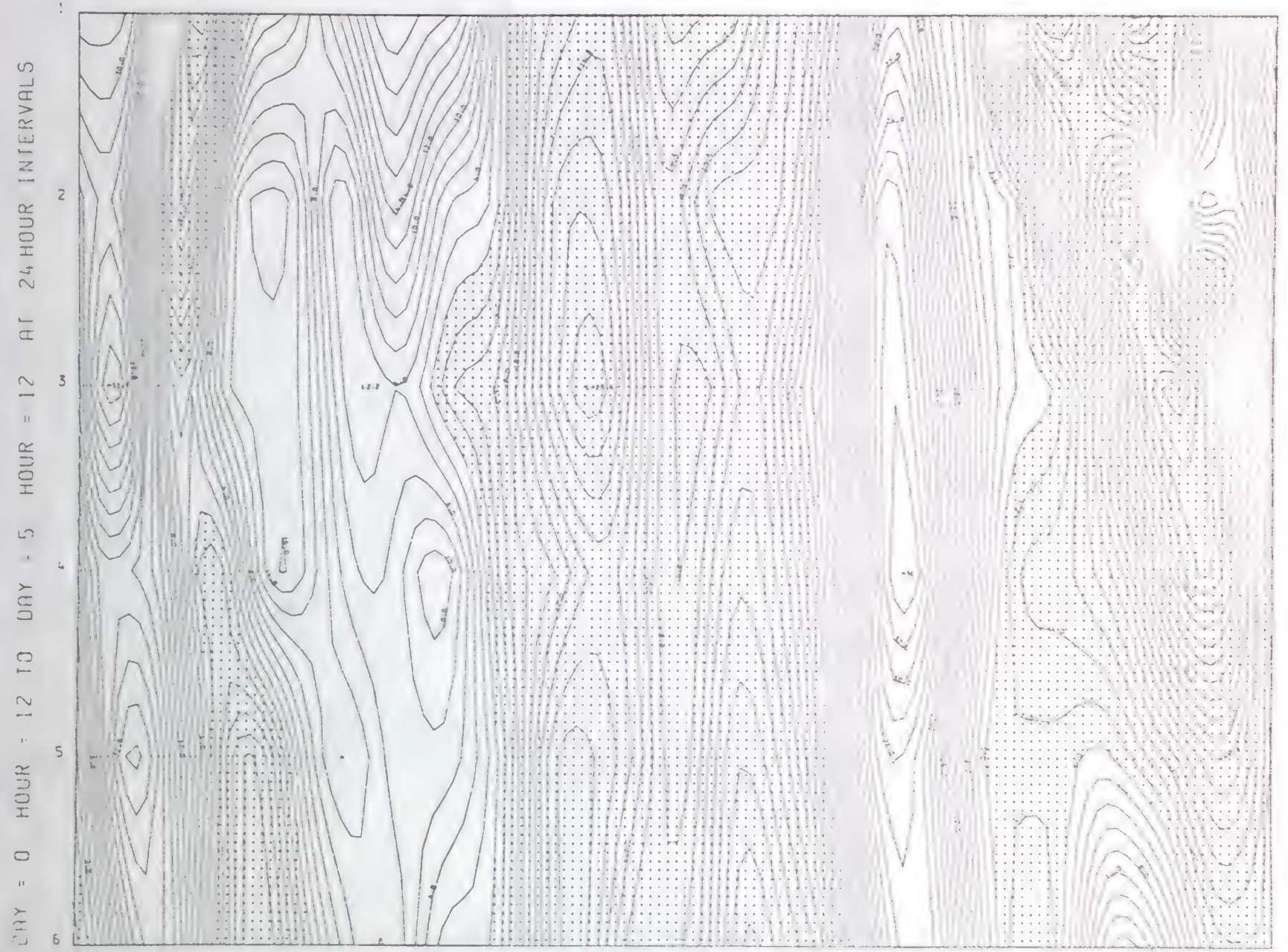
CONTOUR INTERVAL = 2.0

EXPERIMENT ID = C

Figure 5.8

NCAR 5-DAY FORECAST - D000H12 = 12Z JANUARY 12TH 1973

MEAN OF WAVE NOS 1 - 15 AT LATITUDE = 49



CONTOUR INTERVAL = 2.0

LONGITUDE (EAST)

Figure 6.1

EXPERIMENT TIME = D000H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 14/1/73 00Z

Figure 6.3

EXPERIMENT TIME = 0006H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

ACTUAL 17/1/73 00Z

Figure 6.14

EXPERIMENT TIME = 0006H00 PMSL
CONTOUR INTERVAL = 4.00 MB

ACTUAL 17/1/73 00Z

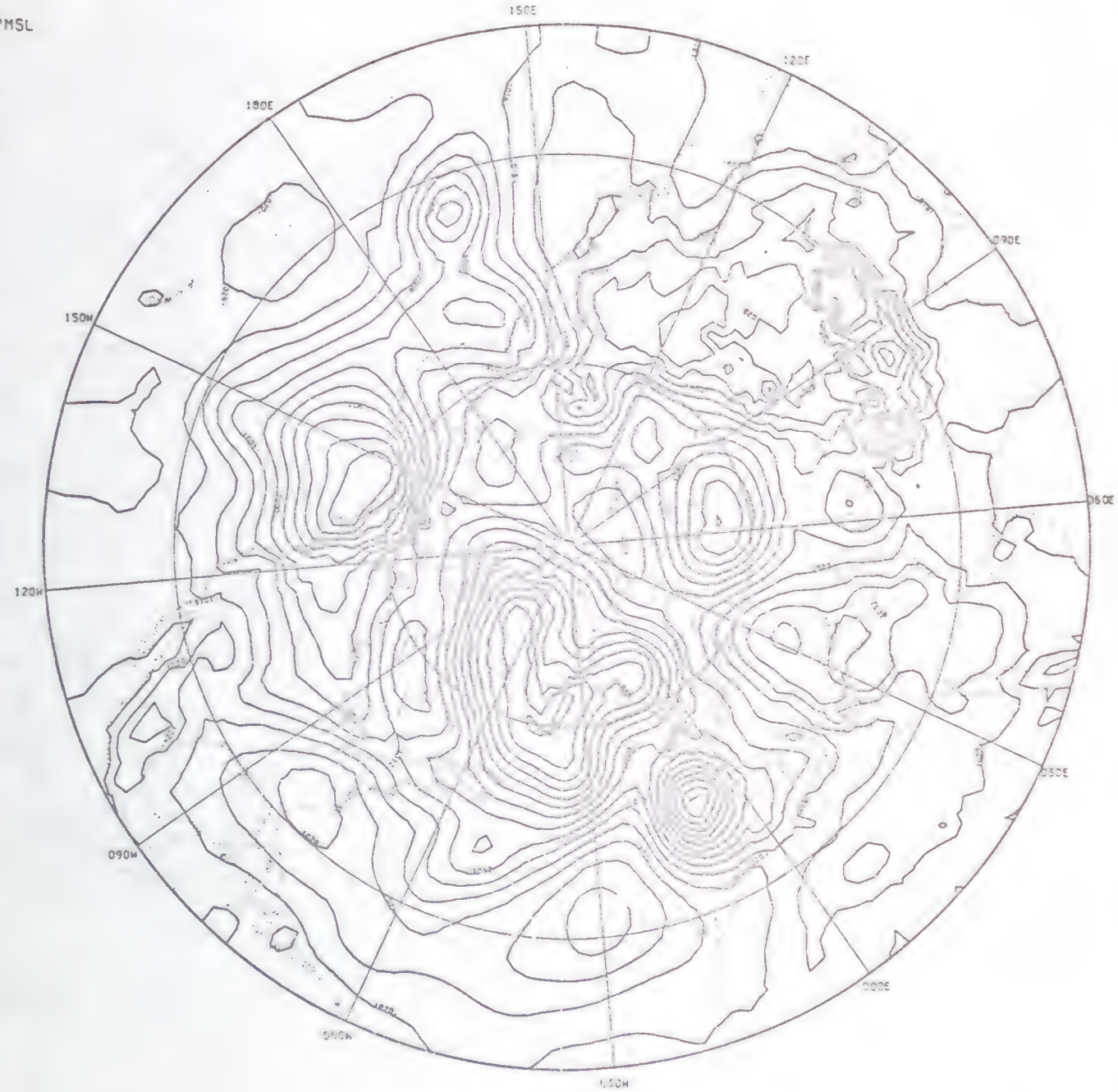


Figure 6.5

EXPERIMENT TIME = D003H00 500 MB HEIGHTS
CONTOUR INTERVAL = 6.00 DEKAMETRES

FORECAST FOR 17/1/73 00Z
FROM DATA 14/1/73 00Z

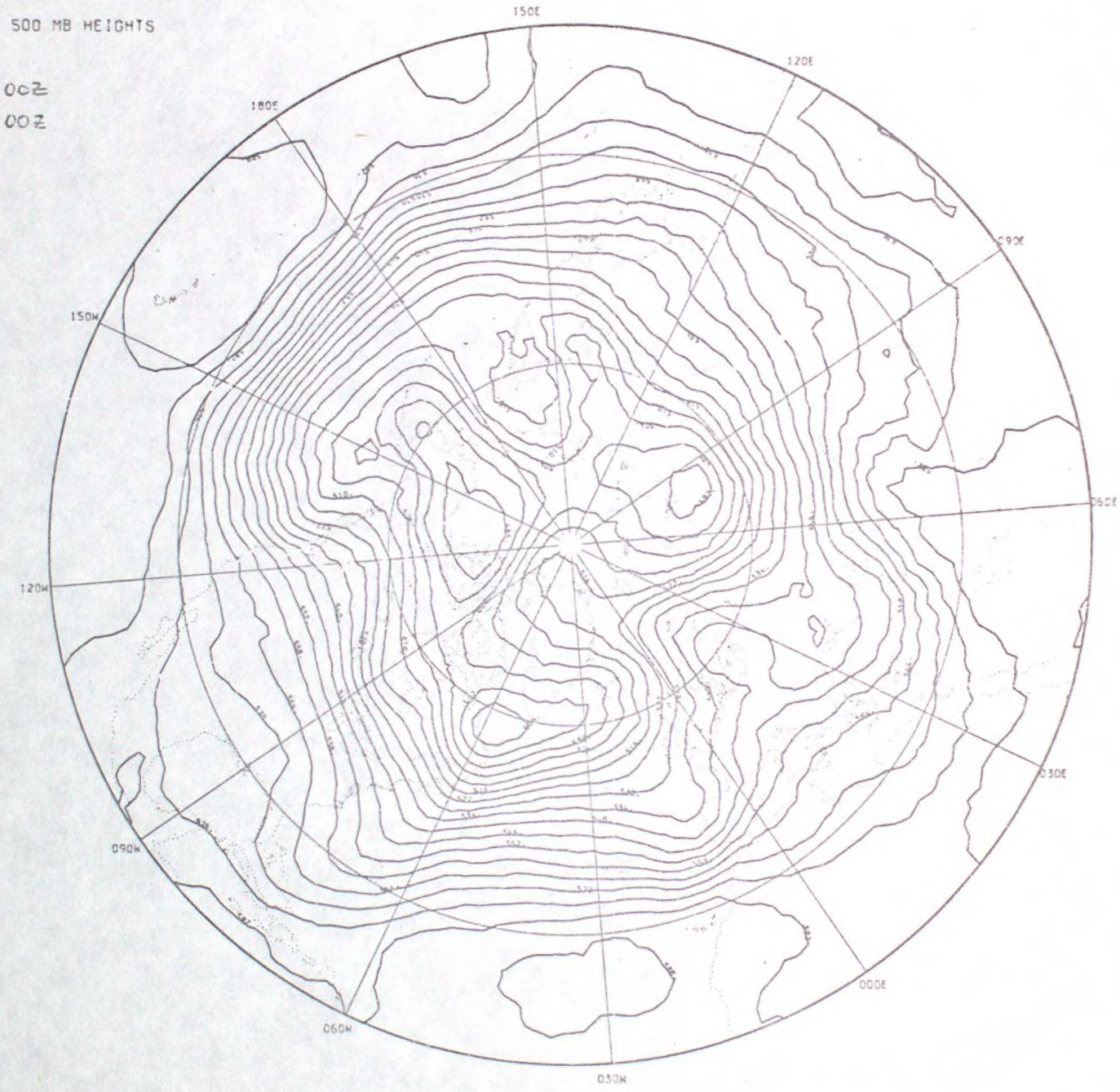


Figure 6.6

EXPERIMENT TIME = D003H00 PMSL
CONTOUR INTERVAL = 4.00 MB

FORECAST FOR 17/1/73 00Z
FROM DATA 14/1/73 00Z

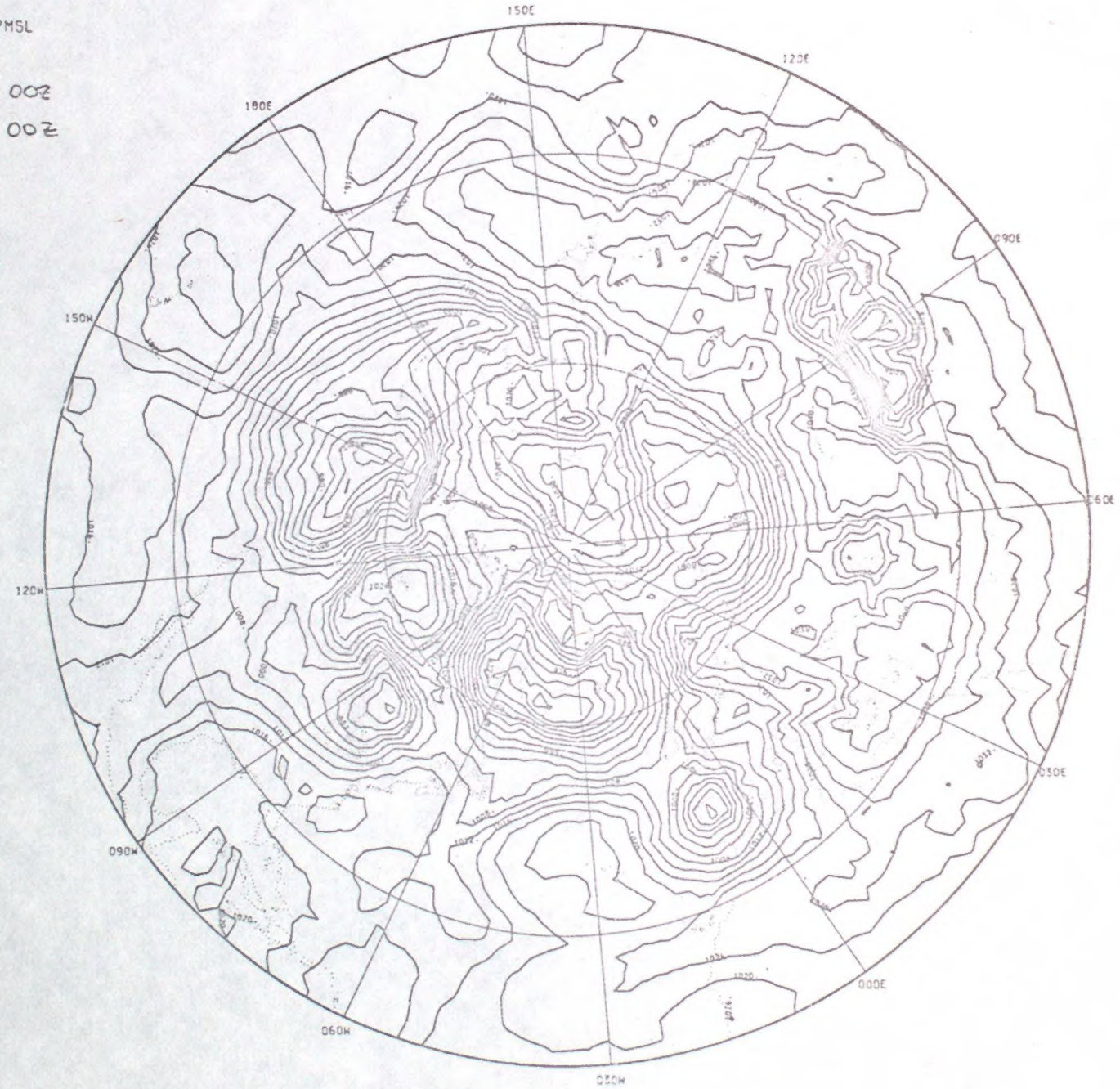


Figure 6.7

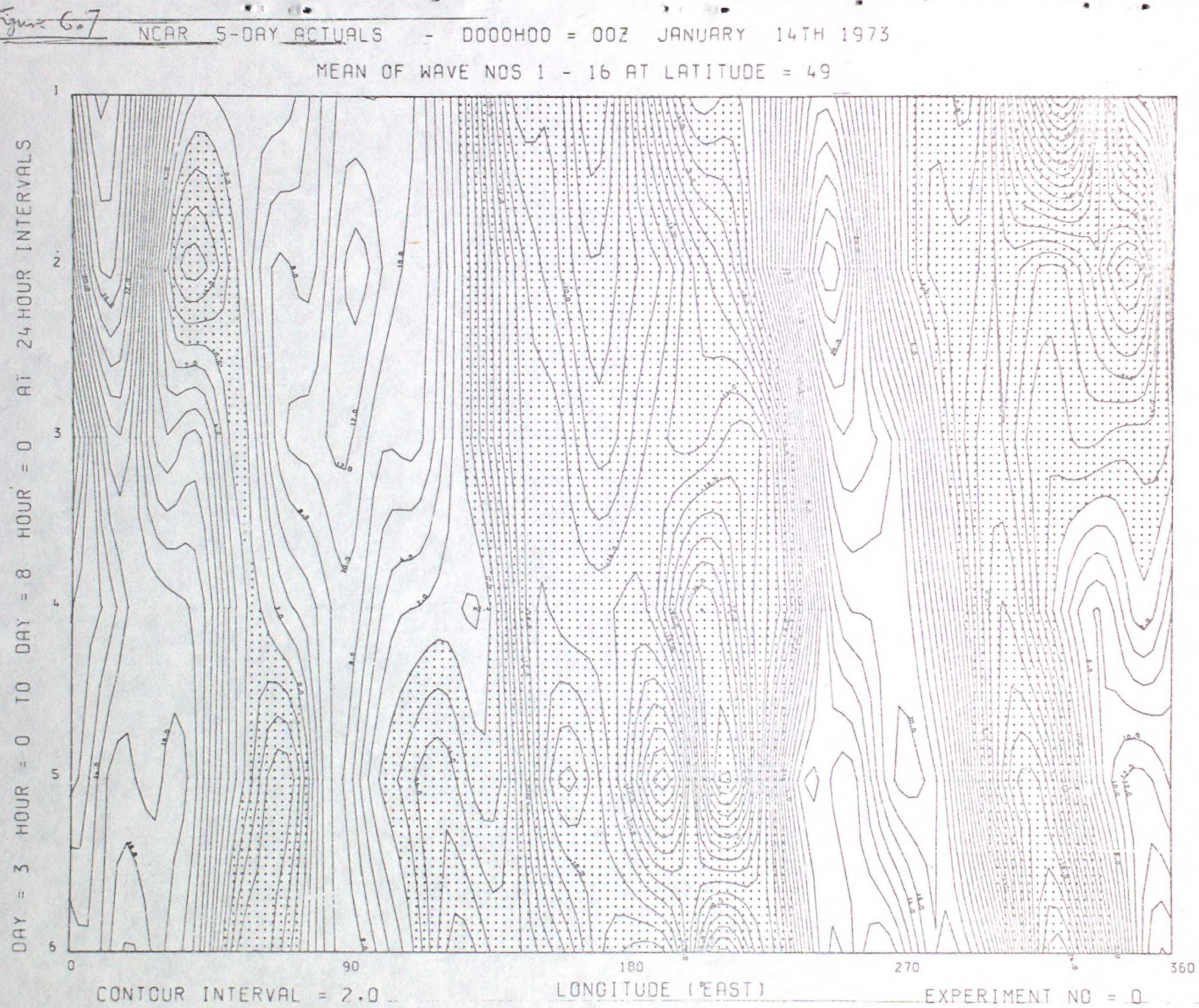
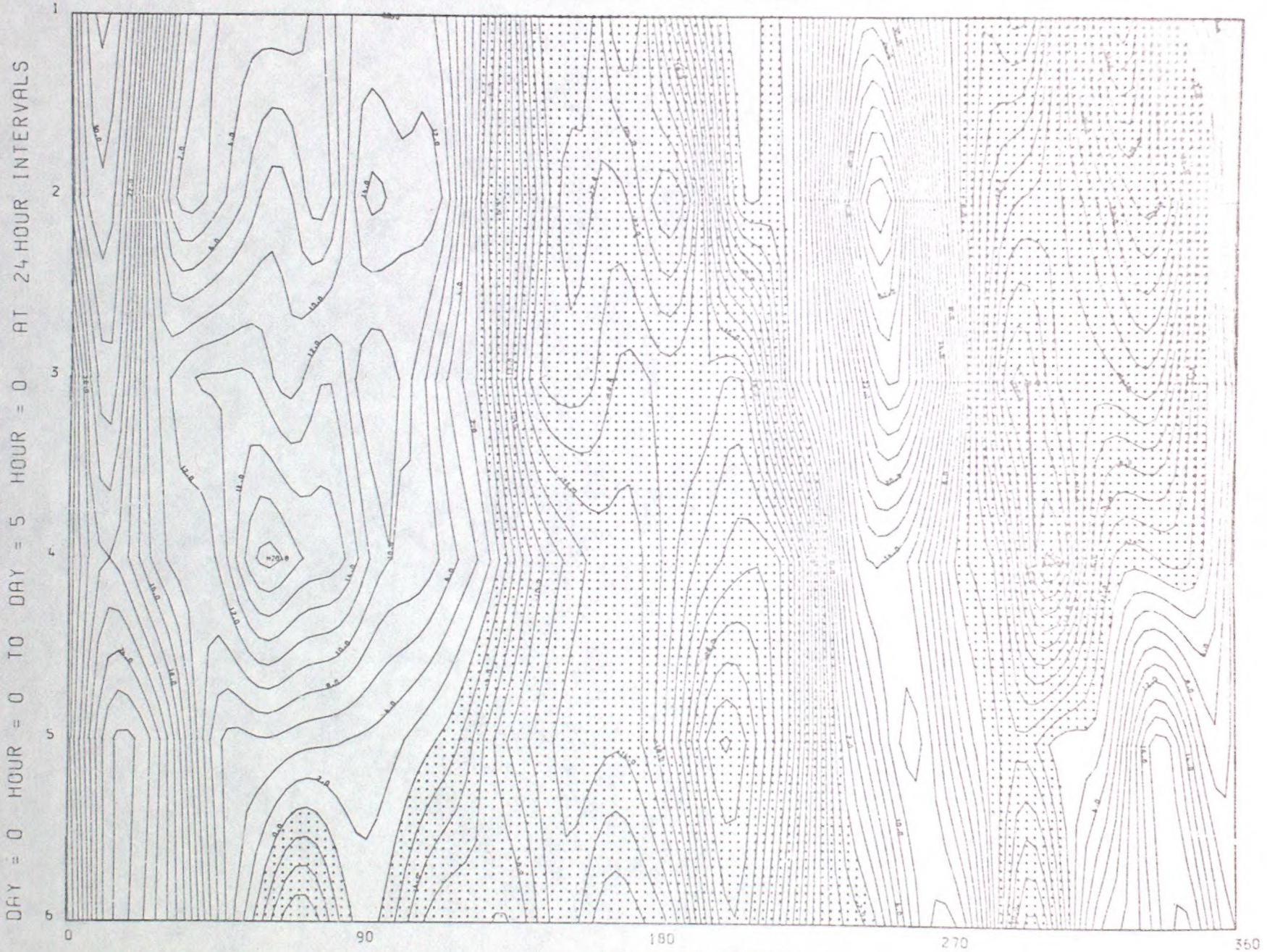

NCAR 5-DAY ACTUALS - D000H00 = 00Z JANUARY 14TH 1973
MEAN OF WAVE NOS 1 - 16 AT LATITUDE = 49
DAY = 3 HOUR = 0 TO DAY = 8 HOUR = 0 AT 24 HOUR INTERVALS
1
2
3
4
5
6
0
90
180
270
360
CONTOUR INTERVAL = 2.0
LONGITUDE (°EAST)
EXPERIMENT NO = 0

Figure 6.8 NCAR 5-DAY FORECAST - DOOOHOO = OOZ JANUARY 14TH 1973

MEAN OF WAVE NOS 1 - 16 AT LATITUDE = 49